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Infrastructure Project Facility
Technical Assistance 9 (IPF9)

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WB21-KOS-ENE-02

GAS DEVELOPMENT PLAN AND REGULATORY FRAMEWORK REVIEW AND ASSISTANCE – GAS DEVELOPMENT PLAN

12 October 2022

*) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

Document information

The Infrastructure Project Facility (IPF) is a technical assistance instrument of the Western Balkans Investment Framework (WBIF) which is a joint initiative of the European Union, International Financial institutions, bilateral donors and the governments of the Western Balkans which supports socio-economic development and EU accession across the Western Balkans through the provision of finance and technical assistance for strategic infrastructure investments. This technical assistance operation is financed with EU funds.

Disclaimer: *The authors take full responsibility for the contents of this report. The opinions expressed do not necessarily reflect the view of the European Union or the European Investment Bank.*

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of abbreviations

ACER	Agency for the Cooperation of Energy Regulators
ALB	Albania
ALKOGAP	Albania-Kosovo Gas Pipeline
API	American Piping Inspection
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
a.s.l.	Above sea level
BAT	Best available techniques
bcm	billion cubic meters
BG	Bulgaria
BVS	Block valve station
CAPEX	Capital expenses
CCGT	Combined cycle gas turbine (power plant)
CEER	Council of European Energy Regulators
CHP	Combined Heat and Power plant
CNG	Compressed natural gas
COP	Coefficient of Performance
CPI	Consumer Price Index
CTMS	Custody transfer metering station
DC	Dispatch Centre
DCVG	Direct Current Voltage Gradient
DH	District Heating
DSO	Distribution System Operator
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECRB	Energy Community Regulatory Board
ECS	Energy Community Secretariat
ECT	Energy Community Treaty
EEA	European Economic Area
EIB	European Investment Bank
ELBC	Electronic Line Break Control
EnC	Energy Community
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
ERO	Energy Regulatory Office
ES	Energy Strategy
ESIA	Environmental and Social Impact Assessment
EU	European Union
EUO	European Union Office
FS	Feasibility Study
GDP	Gas Development Plan
GHG	Greenhouse gases
GWh	Gigawatt-hour
H_2	Hydrogen

HICP	Harmonised Index of Consumer Prices
HP	High pressure
IAP	Ionian Adriatic pipeline
IEA	International Energy Agency
IP	Intersection point
IPA	Instrument for Pre-accession Assistance
IPF	Infrastructure Project Facility
IRENA	International Renewable Energy Agency
ISO	Independent System Operator
ITO	Independent Transmission Operator
KAS	Kosovo Agency of Statistics
KBRA	Kosovo Business Registration Agency
KCC	Kosovo Competition Commission
KEPA	Kosovo Environmental Protection Agency
KIESA	Kosovo Investment and Enterprise Support Agency
KOS	Kosovo
KOSTT	Transmission System Operator in Kosovo
LDAR	Leak Detection and Repair
LHV	Lower Heating Value
LNG	Liquefied natural gas
LP	Low pressure
MAED	Model for Analysis of Energy Demand
MCC	Millennium Challenge Corporation
MESPI	Ministry of Environment, Spatial Planning and Infrastructure
mcm	million cubic meters
MJ	Megajoule
MKD	North Macedonia
MOU	Memorandum of Understanding
MP	Medium pressure
MRS	Metering and regulation station
MS	Member States
MW	Megawatt
MWh	Megawatt-hour
NDS	National Development Strategy
NECP	National energy and climate plan
NER	National Energy Resources
NG	Natural gas
NGV	Natural gas vehicles
NIPAC	National IPA Coordinator
NRA	National Regulatory Authorities
NDT	Non-destructive testing
OPEX	Operating expenses
OS	Odorizing station
P&ID	Process and instrumentation diagram
PJ	Petajoule
PPP	Public-Private Partnership
PRMS	Pressure reducing and metering station

PTS	Pig trap station
PSV	Punto di Scambio Virtuale
REKK	Regional Centre for Energy Policy Research
REMIT	Regulation on Wholesale Energy Market Integrity and Transparency
SAA	Stabilization and Association Agreement
SAC	State Aid Commission
SAD	State Aid Department
SCADA	Supervisory Control and data Acquisition
SEA	Strategic Environmental Assessment
SEE	South East Europe
SKOPRI	North Macedonia-Kosovo gas interconnection (Skopje-Prishtina)
TA	Technical assistance
TANAP	Trans Anatolian pipeline
TAP	Trans Adriatic pipeline
TEP	Third Energy Package
ToR	Terms of Reference
TPP	Thermal power plant
TSO	Transmission System Operator
TWh	Terawatt-hour
TYNDP	Ten Year Network Development Plan
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VAT	Value-Added Tax
VOC	Volatile Organic Compounds
WBIF	Western Balkans Investment Framework

1 SUMMARY AND WAY FORWARD

This report summarizes the Consultant's work in assessing options for the gas development plan of Kosovo. The timing of this assignment is concurrent with significant uncertainties and disruptions in the European energy market caused by the COVID-19 pandemic, conflict in Ukraine, and overall European endeavor to transform and decarbonize its energy sector. All these cause significant changes in energy and material prices, which significantly affect the economic analyses in this assignment.

The energy strategy of Kosovo, currently in development, considers several scenarios, and one of those considers the use of natural gas.

Gas in Kosovo is considered a transition fuel in the decarbonization of Kosovo's economy. Gas infrastructure is considered such that it can also transport hydrogen, in case future developments enable its widespread use.

It is considered that gas to Kosovo would be supplied via the SKOPRI pipeline connection between Skopje and Prishtina. Gas would, in turn, be sourced from Bulgaria via the existing pipeline from Zdihilovo to Skopje or Greece via pipeline Nea Mesimvria-Negotino currently in preparation for construction. Ultimate sources of natural gas for Kosovo could be gas from Russia, Greek LNG, TAP, or Croatian LNG (via IAP).

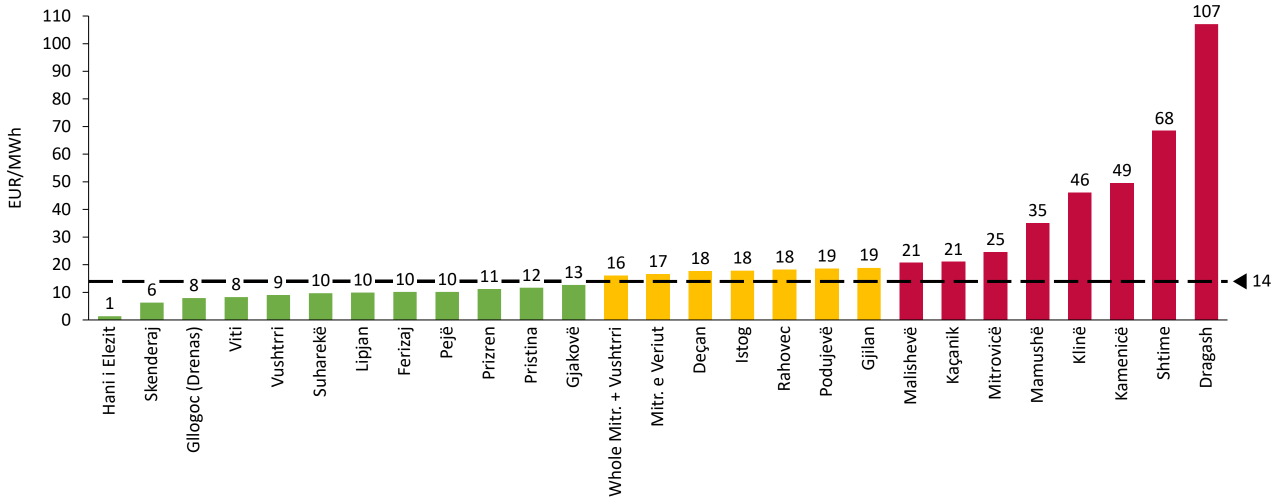
Usage of natural gas in Kosovo is expected in the residential, services, industry, and power generation sectors. Gas is potentially competitive in all considered sectors. Potential gas demand was developed based on modeling a number of parameters, including Gross domestic product, population, energy efficiency, and other parameters. Gas-to-power demand was estimated based on the input from the Beneficiary until 2040 and further modeled by the Consultant until 2060.

The estimated potential annual gas demand was geographically distributed, as provided in **Figure 1** (for settlements larger than 20.000 inhabitants). The size of the circle indicates the potential gas demand (excluding gas-to-power demand). Expected patterns of gas use and weather extremes were taken into account when estimating peak hourly gas demands needed for dimensioning the transmission system.

FIGURE 1 – GEOGRAPHICAL DISTRIBUTION OF THE POTENTIAL GAS DEMAND

Provisional distribution networks were developed for those settlements. This enabled a preliminary estimate of distribution tariffs for gas consumers in each settlement, as provided in **Figure 2**.

FIGURE 2 – ESTIMATE OF TOTAL DISTRIBUTION TARIFFS



Only settlements with an acceptable level of distribution costs (green and yellow) were selected for further analysis. Note that the settlements with distribution costs slightly above the provisionally assessed acceptable tariff of 14 €/MWh were allowed as well due to the possibility of applying a single average distribution tariff for all Kosovo consumers.

Based on the geographical distribution of selected settlements' demands, the transmission system was routed, and preliminary hydraulic calculations were performed. This resulted in the proposed construction of SKOPRI, the gas Ring, and several transmission branches, constituting a **Large gasification scenario.** That would enable the gasification of the following distribution areas: Hani I Elezit, Skenderaj, (Drenas Viti, Vushtrri, Mitrovica e Veriut, Suharekë, Lipjan, Ferizaj, Pejë, Prizren, Prishtinë, Gjakovë, Deçan, Istog, Rahovec, Podujevë, and Gjilan. This scenario results in peak hourly gas demand of 226 000 m^3/h, while peak annual gas demand of 655 mcm is reached in 2040. Obtained gas demand was used to reiterate the transmission system model and yield revised system parameters, including system CAPEX.

The overall length of the transmission system in this scenario is 279,6 km. CAPEX for construction of the transmission system is estimated at 165,8 mln € (with DN600 SKOPRI dimension) and 377,5 mln € for distribution systems, yielding a total estimated CAPEX of 543,3 mln €. Note that the distribution system CAPEX also contains the transmission branches necessary to connect the distribution areas to the main transmission system (Ring or SKOPRI). Distribution areas with existing or planned district heating networks could use natural gas in district heating plants, thus avoiding the gas distribution network costs.

The transmission system tariff is slightly below 4 €/MWh, while the distribution tariff varies from settlement to settlement in the range from 1 to 19 €/MWh. The average gas distribution tariff for all distribution consumers is 11,5 €/MWh, yielding the overall gas network costs for Kosovo consumers of 15,4 €/MWh. **Figure 3** of the respective gas transmission system with average tariffs over the lifetime of the project is provided below.

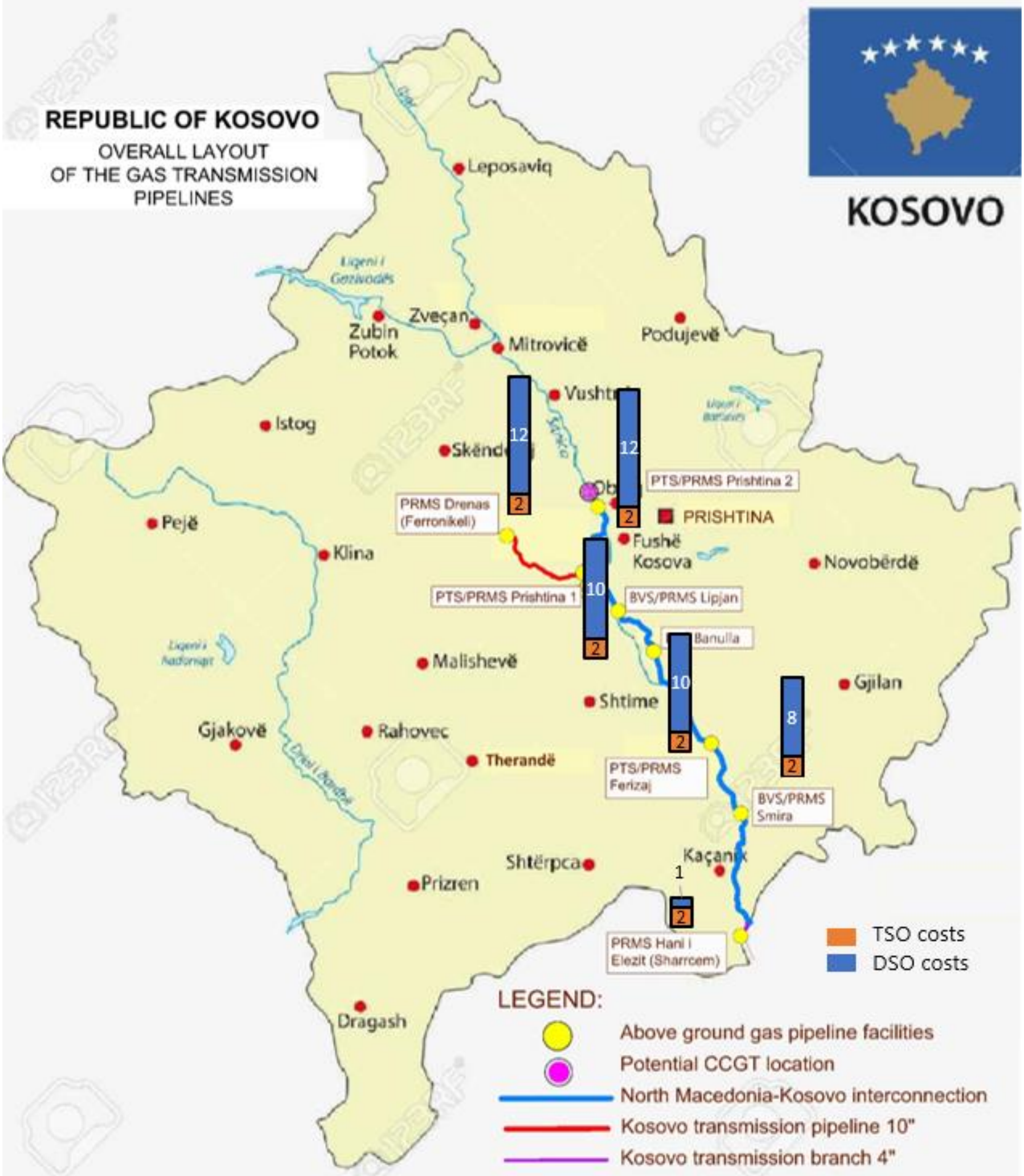
FIGURE 3 – KOSOVO GAS TRANSMISSION SYSTEM LARGE GASIFICATION SCENARIO WITH AVERAGE TARIFFS

The Consultant also considered the **Small gasification scenario** that included the construction of SKOPRI with an extension to Drenas. That would enable the gasification of distribution areas along the SKOPRI route: Hani I Elezit, Viti, Ferizaj, Lipjan, Prishtinë , and Drenas. This scenario results in peak hourly gas demand of 157 000 m^3/h (reached in 2045), while peak annual gas demand of 458 mcm is reached in 2036. Again, the obtained gas demand was used to reiterate the transmission system model and yield revised system parameters, including system CAPEX.

The overall length of the transmission system in this scenario is 90,2 km. CAPEX for construction of the transmission system is estimated at 69,9 mln € (with DN500 SKOPRI dimension), and 130,8 mln € for distribution systems, yielding a total estimated CAPEX of 200,7 mln €. Similarly as before, distribution areas with existing or planned district heating networks could use natural gas in district heating plants, thus avoiding the gas distribution network costs.

The transmission system tariff is 2,3 €/MWh, while the distribution tariff varies between distribution areas in the range from 1 to 12 €/MWh. The average gas distribution tariff for all distribution consumers is 9 €/MWh, yielding the overall gas network costs for Kosovo consumers of 11,3 €/MWh. **Figure 4** of the respective gas transmission system with average tariffs over the lifetime of the project is provided below.

FIGURE 4 – KOSOVO GAS TRANSMISSION SYSTEM SMALL GASIFICATION SCENARIO WITH AVERAGE TARIFFS



Depending on the pressure on the MKD-BG border, the capacity of the SKOPRI pipeline may be sufficient for the gasification of additional settlements. The transmission tariff is gradually increasing as the system is expanded further from Drenas.

The supply of LNG to Kosovo is generally unfeasible compared to the supply of piped gas. However, that may be an option for a limited number of specific consumers if a transmission system isn't built. The average specific cost of LNG transport is estimated between 5 and 6 €/MWh. The nearest LNG terminal from where LNG could be trucked or railed to Kosovo is currently in construction in Alexandropoulis.

CNG could be considered as an option for supplying gas to a limited number of specific consumers in case SKOPRI is built, but without a gas transmission system in Kosovo (Ring). Natural gas would be compressed in Prishtina and trucked to consumers across Kosovo. The average specific cost of CNG transport (from Prishtina across Kosovo) is from 19 to 21 €/MWh.

Based on the findings presented above, supplying gas to Kosovo can be done at acceptable infrastructure costs. , The level of acceptable costs will determine the reach of gasification. SKOPRI is the backbone of the future Kosovo gas transmission system. Among others, it would supply a CCGT envisaged in Prishtina. That CCGT, as an anchor load, is also a key contributor to SKOPRI feasibility.

Considering the goal of decarbonization by 2060, the feasibility of the overall gas system development is burdened with an expected decline in gas demand after 2045 and overall limited time for investment recouping. It is possible that the pipeline will be in use after 2060 for the transportation of hydrogen and that hydrogen as an energy carrier will be able to sustain higher transmission tariffs. Using a conservative approach, none of those has been taken into account in this analysis.

In planning further steps, the key decision is whether to proceed with SKOPRI as DN500 or DN600. If natural gas pressure on the BG-MKD border is raised to 54 bar, DN500 SKOPRI could deliver 186 000 m3/h to Prishtina (at 30 bar necessary for the operation of CCGT). Under the same assumptions, and according to the Large gasification hydraulic model, DN600 SKOPRI could supply 260 000 m^3/h to Prishtina. , The addition of a compressor at the start of SKOPRI could significantly increase those figures. Note that DN500 SKOPRI CAPEX (KOS part) is estimated at 61,5 mln €, while DN600 SKOPRI CAPEX (again KOS part only) is estimated at 72 mln €. **In case Kosovo envisages large gasification, then DN600 SKOPRI is more appropriate. If Kosovo plans to start with limited (small) gasification, DN500 may be a more sensible approach.**

The Beneficiary has suggested considering additional scenarios: "industrial" and "industrial only".The industrial scenario assumes no development of distribution networks and increased development of the Kosovo industry sector. Therefore gas demand in that scenario does not include households and services gas demand and increases the estimated industry gas demand by 30%. "Industrial only" is a further modification considering only gas demand for industry (increased by 30% over small and large gasification scenarios), and no gas demand for power generation. Both of these additional scenarios have been considered with transmission system layout as in the small gasification scenario and, alternatively, without branch to Drenas. In case Drenas and Skenderaj are not connected, Vushtri and Mitrovica are connected via Obiliq. The layout of that transmission system is provided in **Figure 5**.

The **industrial scenario** results in peak hourly gas demand of 134 000 m^3/h, while peak annual gas demand of 449 mcm is reached in 2036. The overall length of the transmission system in this scenario is 134,3 km, or 105,8 km, without connections to Drenas and Skenderaj CAPEX for construction of the transmission system is estimated at 87,9 mln €, or 73,2 mln € without a branch to Drenas and Skenderaj. The transmission system tariff is 2,1 €/MWh, No distribution is envisaged, and thus all CAPEX is included herein. Note that in small and large gasification scenarios, several connection branches were included in the distribution CAPEX.

The **industrial-only scenario** results in peak hourly gas demand of 43 000 m^3/h, while the peak annual demand of 213 mcm is reached in 2051. The overall length of the transmission system is the same as in the case of the industrial scenario. This scenario allows for decreasing in the pipeline diameter of SKOPRI to DN400. Thus the CAPEX is decreased to 78,7 mln €, or 64 mln € without a branch to Drenas and Skenderaj. The transmission system tariff is 4.6 €/MWh.

FIGURE 5 – KOSOVO GAS TRANSMISSION SYSTEM INDUSTRIAL SCENARIO W/O CONNECTIONS TO DRENAS AND SKENDERAJ

Table 1 summarizes the considered gasification scenarios.

TABLE 1 – DIFFERENCES BETWEEN CONSIDERED SCENARIOS

	Large gasification scenario	Small gasification scenario	Industrial scenario	Industrial only scenario
Gas to power	380 MW CCGT	380 MW CCGT	380 MW CCGT	-
Peak hourly gas demand	226 000 m³/h	157 000 m³/h	134 000 m³/h	43 000 m³/h
Peak annual gas demand	655 mcm (2040)	458 mcm (2036)	449 mcm (2036)	213 mcm (2051)
Transmission system length	279,6 km	90,2 km	134,3 or 105,8 km	134,3 or 105,8 km
SKOPRI dimension	DN600	DN500	DN500	DN400
Transmission system CAPEX	165,8 mln €	69,9 mln €	87,9 or 73,2 mln €	78,7 or 64 mln €
Distribution systems CAPEX	377,5 mln €	130,8 mln €	-	-
Total CAPEX	543,3 mln €	200,7 mln €	87,9 or 73,2 mln €	78,7 or 64 mln €
Transmission tariff	3,9 €/MWh	2,3 €/MWh	2,1 €/MWh[1]	4,6 €/MWh[2]
Average distribution tariff	11,5 €/MWh	9 €/MWh	-	-

Ministry of Economy of Kosovo, the Beneficiary of this study, has declared the « Industrial Scenario » as its preferred scenario upon which further work should be based.

[1] *Tariff for lower CAPEX – w/o connection to Drenas*

[2] *Tariff for lower CAPEX – w/o connection to Drenas*

2 INTRODUCTION

This report is delivered within the assignment WB21-KOS-ENE-02 Gas Development Plan and Regulatory Framework Review and Assistance. This assignment is a sub-project within the Western Balkans Investment Framework - Infrastructure Project Facility 9 (WBIF-IPF9). The ToR for this assignment was completed in April 2021, and the work on this assignment started in October 2021. This assignment aims to assist the Beneficiary, the Kosovo Ministry of Economy, in making informed decisions regarding developing its natural gas infrastructure and the overall introduction of natural gas into its energy mix.

In Kosovo, currently, there is no functional gas infrastructure and no connections to the regional gas network (which results in no natural gas market). The strategic objective of the Kosovo Government is the diversification of sources of energy supply to increase the security of energy supply. The development of gas infrastructure is covered in the Energy Strategy of Kosovo 2017-2026. To the Consultant's understanding, revision of the Energy Strategy, which was ongoing at the time of drafting this report, considers one scenario that includes gasification.

Kosovo is not a signatory to the Paris agreement. However, the Consultant understands Kosovo intends to decarbonize its economy in alignment with the Paris agreement. The decarbonization agenda will significantly change Kosovo's energy systems, which depend on lignite today. It is unclear if Kosovo will take the position to reach the zero-emissions goal by 2050[3] or by some later point in time, as several other European countries have announced.

This document deals with the potential role of natural gas in the future development of Kosovo energy systems and achieving decarbonization goals.

This document builds upon the findings of previous documents prepared within the sub-project: Inception report, Gas demand report, Gas supply report, Institutional and Market review, and Tariff study.

2.1 Scope and objectives

The objective of this assignment was to prepare a Gas Development Plan (GDP) and Regulatory Framework Review and Assistance for Kosovo. In addition, the Strategic Environmental Assessment is being developed and subjected to the national procedure in parallel with this document. After completing the Gas Development Plan, the Consultant will develop a Project Identification Plan to identify and rank a portfolio of feasible priority projects. The documents are developed in line with the national legislation of Kosovo, EU environmental and social laws, regulations, good international practice, and EBRD requirements, including those outlined in the 2019 EBRD ESP.

The detailed scope of the assignment is outlined in the Terms of Reference (ToR).

[3] *For the purposes of this assignment, the Consultant assumed Kosovo will reach zero carbon emissions by 2060.*

3 THE GENERAL CONTEXT

3.1 The socio-economic environment

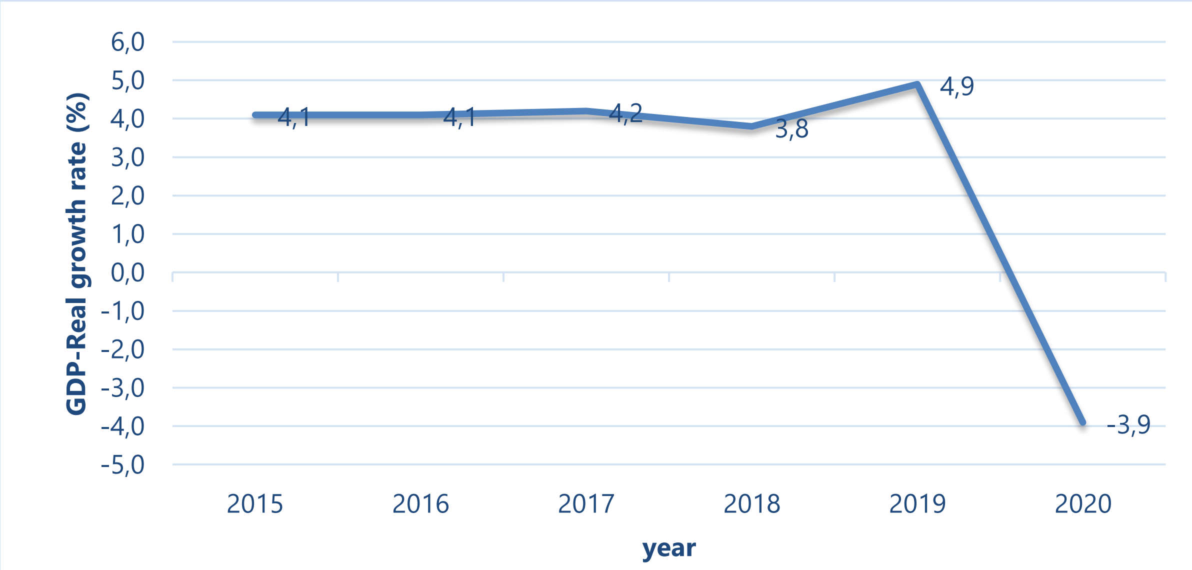
In 2019, the total Kosovo population was estimated at 1.782.115 [KAS "Statistical Yearbook of the Republic of Kosovo, 2020"], 38,1% of which lives in urban areas [KAS ("Energy consumption in households 2015")].

In 2019 the nominal value of Kosovo Gross domestic product reached the value of 7,1 billion €. In real terms, it results that the Gross domestic product for 2019 marked a growth of about 4,2 percent. Structure of Kosovo Gross domestic product in 2019 was the following: agriculture 8,1 percent, construction 9,0 percent, mining 2,2 percent, manufacturing 12,3 percent, services 58,6 percent, and energy 4,2 percent [1].

Economic activity in 2020 in Kosovo was characterized by an unprecedented shock caused by the COVID-19 pandemic. The measures taken to maintain public health due to the pandemic, mainly in the context of restricting movement and physical distancing, were reflected in a general decline in economic activity. Taken restrictive measures thus have resulted in an average decline in economic activity as per the data of the Kosovo Agency of Statistics (KAS) and consequently real Gross domestic product decreased by 3,9 percent overall in 2020 compared to 2019 as shown in **Figure 6** ([2],[3]).

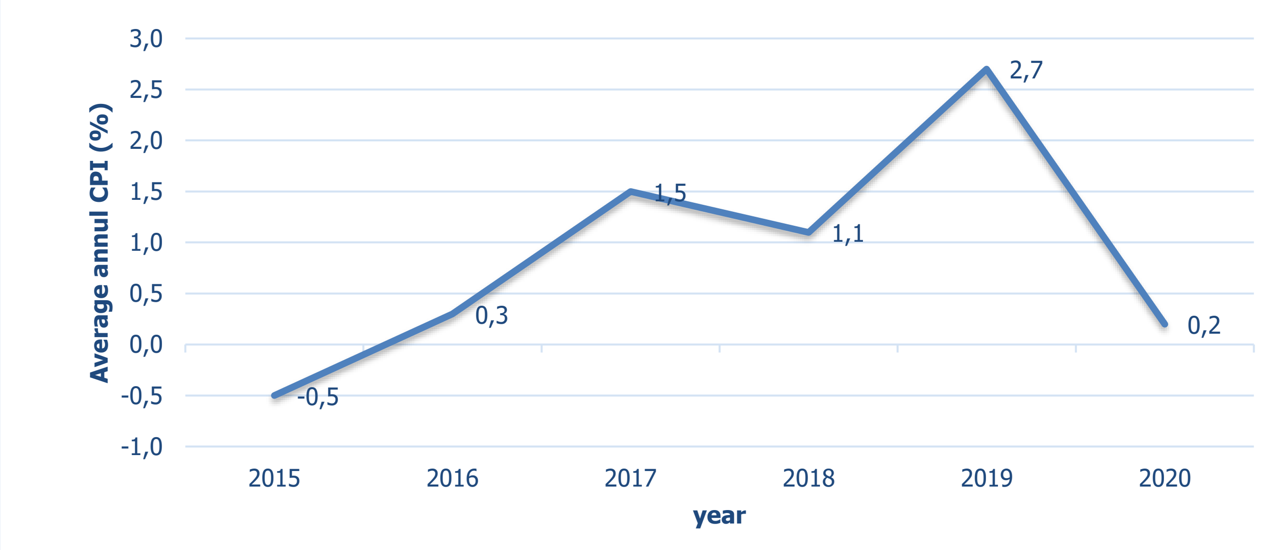
The decline in the Gross domestic product rate was strongly driven by a decrease in net investments of 18,8 percent and net exports by 17,5 percent. According to KAS, the highest decline was recorded in the transport and storage sector (25,5 percent), construction (24,3 percent), and hotels and restaurants sector (21,8 percent). On the other hand, a higher growth was recorded in the health sector and social work (16,9 percent), processing industry (11,7 percent), information and communication (10 percent), and electricity and gas supply (9,4 percent). Consumption, as the main component of domestic demand, marked a real growth of 6,7 percent, supported by an increase in private consumption of 7,0 percent and public consumption of 4,4 percent. Remittances, as an important source of financing for private consumption, increased by 15,1 percent compared to 2019 [2].

FIGURE 6 – GROSS DOMESTIC PRODUCT GROWTH RATE FROM 2015 UNTIL 2020



The decline in aggregate demand and the dynamics of commodity prices in international markets were reflected in weak inflationary pressures in Kosovo. The price level growth rate, measured by the consumer price index (CPI)[4], showed a slowdown when compared to 2019 (2,7 percent) and was 0,2 percent. The slowdown was mainly influenced by transport prices which declined by 5,8 percent, clothing prices (0,9 percent), recreation and culture prices (0,6 percent), and electricity and gas prices, (0,1 percent). Going forward, price fluctuation in Kosovo is mainly determined by price fluctuation in international markets, due to the high dependence of Kosovo's economy on imports. The import price index marked an average decline of 1,9 percent in 2020 mainly driven by the decline in prices of mineral products (15,9 percent) as well as prices of textile products (13,8 percent). The highest price increase was recorded for prices of plant products (13,9 percent) [2].

FIGURE 7 – AVERAGE ANNUAL INFLATION RATE FROM 2015 UNTIL 2020



In 2020, the labour force participation rate in Kosovo was 38,3 percent, which compared to 2019 shows a decrease in the labour force participation rate by 3,2 percentage points. As per the Labour Force Survey, the average employment rate[5] was 28,4 percent, which represents a decrease of 2,3 percentage points compared to 2019. The employment rate turned out to be higher among men compared to women, where 42,8 percent of men of working age were employed versus 14,1 percent of women. According to the results of the survey, the employment rate among women has decreased by 0,4 percentage points, while among men it has decreased by 4,1 percentage points compared to 2019 [2].

Despite the pandemic and the contraction of economic activity, statistics of the official labour market in Kosovo showed that the average unemployment rate in 2020 was 25,9 percent, almost similar level compared to the same period of the previous year when the rate was 25,57 percent. According to KAS, the labour market in Kosovo is characterized by a higher unemployment rate among women (32,3 percent), with the age group of young women (age group 15 to 24) having the highest unemployment rate (49,1 percent), while the unemployment rate among men was significantly lower and was 23,5 percent as shown in **Figure 8** ([2],[4]).

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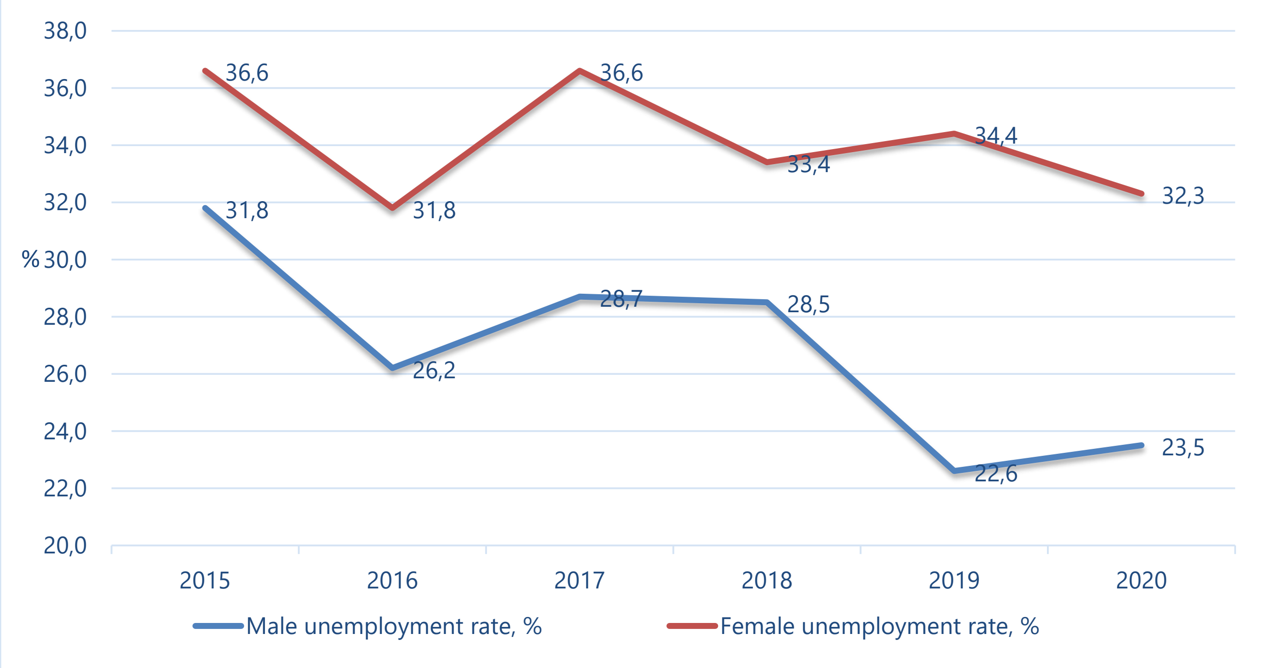
[4] *The Consumer Price Index (CPI) is a measure of the aggregate price level in an economy. The CPI consists of a bundle of commonly purchased goods and services. The CPI measures the changes in the purchasing power of a country's currency, and the price level of a basket of goods and services.*

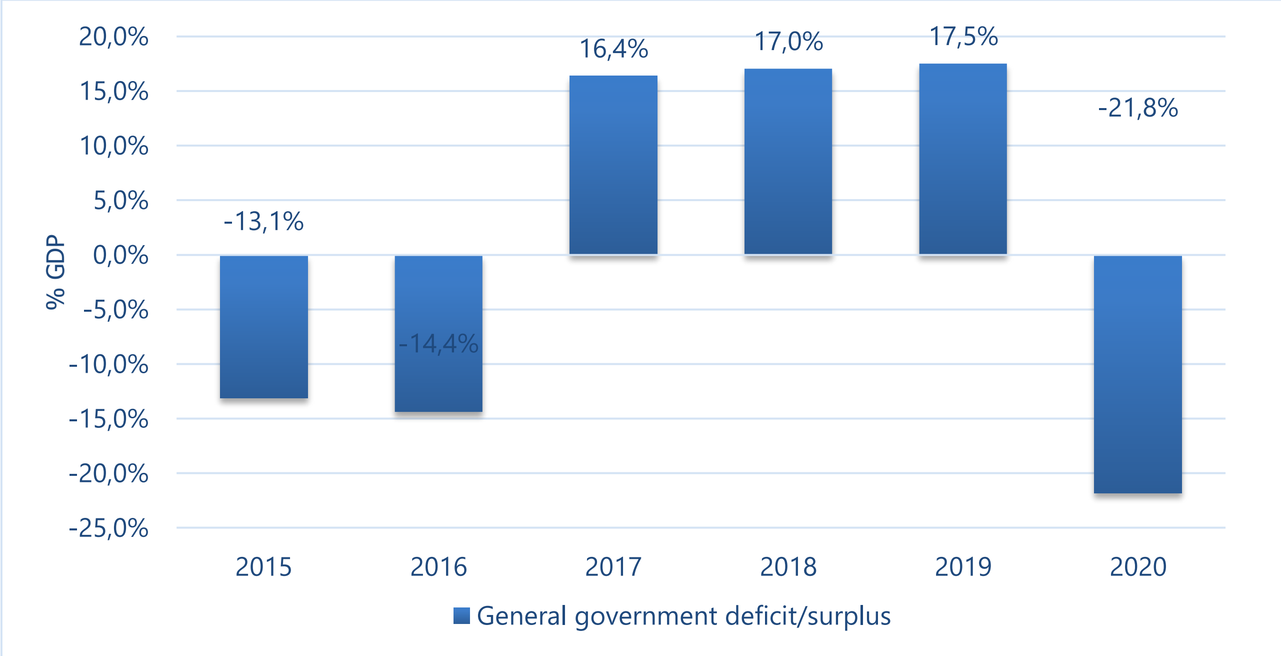
[5] *The employment rate represents the percentage of the working-age population that is employed.*

FIGURE 8 – UNEMPLOYMENT RATE FROM 2015 UNTIL 2020



Budget revenues in 2020 reached a net value of 1,7 billion €, which represents an annual decline of 8,8 percent, while budget expenditures reached the value of 2,2 billion €, which represents an annual increase of 6,5 percent. Consequently, the primary budget deficit has reached 7,1 percent of Gross domestic product, compared to 2,6 percent in 2019. The increase in budget expenditures by 6,5 percent was lower compared to 2019 when there was an increase of 7,2 percent. The category that drove an accelerated increase in expenditures was the current expenditures, which increased by 18,6 percent (subsidies and transfers increased by 38,4 percent), while capital expenditures decreased by 28,4 percent. Government expenditures on wages increased by 7,3 percent and reached the value of 660,8 million €, while government expenditures on goods and services (including municipal expenditures) increased by 0,2 percent and reached the value of 296,3 million €. Public debt in 2020 has reached 1,5 billion €, which is 23,9 percent higher compared to 2019. As a percentage of Gross domestic product, public debt has reached 21,8 percent, compared to 17,5 percent in 2019 shown in **Figure 9**. Public debt growth is attributed to the increase in domestic debt by 21,5 percent (which reached 961,9 million €) and the increase in public external debt by 28,6 percent. External public debt has reached the level of 525,8 million € or 35,3 percent of total public debt [2].

FIGURE 9 – PUBLIC DEBT AS % OF GROSS DOMESTIC PRODUCT FROM 2015 UNTIL 2020



Demand for investing in treasury bills and government bonds was lower than in the previous year. In 2020, the average interest rate on Kosovo Government Securities increased to 2,1 percent, compared to 1,8 percent in 2019. The increase in the interest rate is related to the continued increase in the share of long-term securities due to the domination, in the structure of Kosovo Government Securities, of bonds with maturities from three and five years [2].

The current account deficit in 2020 has increased by 20,4 percent, marking the value of 480,7 million €. The current account deficit was 7,1 percent of Gross domestic product in 2020, compared to 2019 when it was 5,6 percent. The increase in exports of goods and the significant decline in imports due to the decline in economic activity have affected the deficit in trade in goods to decline by 9,4 percent (4,5 percent increase in 2019) and reach about 2,8 billion €. Going forward, the trade deficit in goods was 41,5 percent (43,9 percent in 2019). The value of exports of goods amounted to 475,0 million €, which corresponds to an annual increase of 23,8 percent (4,4 percent increase in 2019). In 2020, imports of goods decreased by 5,7 percent (4,5 percent increase in 2019) and reached 3,3 billion € as shown in **Figure 10**. The aforementioned decrease can be attributed to the decline in aggregate demand globally [2].

FIGURE 10 – TRADE BALANCE FROM 2015 UNTIL 2020

A summary of the key macroeconomic trends for the Republic of Kosovo is shown in **Table 2.**

TABLE 2 – MACROECONOMIC INDICATORS FOR 2019 AND 2020

Item	Unit	Annual data	
		2019	2020
Gross domestic product[1]			
Nominal Gross domestic product	Million €	7.056	6.772
Real Gross domestic product	Million €	6.989	6.679
Gross dom. prod. Real growth rate	Percentage	4,8	-5,3
Prices[1]			
Consumer prices (HICP)	Percentage	2,7	0,2
Producer price index	Percentage	0,9	-0,6
Import prices index	Percentage	2,3	-1,9
Labour market[1]			
Employment (ages 15-64)	Thousands	372	368
Unemployment (ages 15-64)	Thousands	130	120
Inactive persons (ages 15-64)	Thousands	711	733
External sector			
Current account balance	Million €	-399,5	-472,2
Import of goods and services	Million €	3.982,60	3.651,60
Exports of goods and services	Million €	2.068,30	1.470,00
Remittances (inflows)	Million €	851,7	980,1
Direct investments in Kosovo	Million €	254,6	345,7
Exchange rate[2]			
Exchange rate € vs. USD	Average	1,1195	1,1422
Interest rates			
Interest rates on new loans	Percentage	6,5	6,2
Loans to non-financial corporations	Percentage	6,3	6,0
Loans to households3	Percentage	6,8	6,5
Bank loans			
Bank loans to the domestic sector	Million €	3.031,90	3.246,60
Loans to non-financial corporations	Million €	1.916,90	2.054,80
Loans to households[3]	Million €	1.102,00	1.179,90
General government [4]			
Revenue (including loans)	Million €	2.212,90	2.196,60
Expense (including repayment of loans)	Million €	2.144,60	2.323,20
Debt stock value	Million €	1.201,50	1.487,70
Debt as % of Gross domestic product	Percentage	17,5	21,8
Stock of government securities	Million €	791,9	961,9
Population [5]			
Kosovo population	Thousands	1.795,67	1.782,10

Note on data sources: ***1*** *Kosovo Agency of Statistics.* ***2*** *ECB. Averages based on daily euro foreign exchange reference rate.* ***3*** *Including non-profit organizations serving households.* ***4*** *Source: Ministry of Finance.* ***5*** *The latest figures are provisional.*

Source: [5],[6]

3.2 The context within the energy sector and relevant strategies

The development of Kosovo's energy sector with the option of building gas infrastructure should be seen in context with i) the European Green Deal and the transitional role of natural gas, the WB Green agenda, and the Initiative for coal regions in transition ii) Kosovo's commitments from international agreements primarily Energy Community Treaty and iii) Kosovo's policies and strategies addressing economic development, environment, and climate change, regional development, spatial planning, etc.

From a policy perspective, a key planning document on the state level was the National Development Strategy (NDS), adopted in 2016 for a period of 5 years, and Roadmap for its implementation. Following the Governmental Concept for preparation of NDS 2030, a new document is under drafting procedure. The NDS 2030 will be the main strategic document providing the vision for the sustainable development of the country and the direction of the strategic and budgetary policies in the following period. The NDS will contain the key pillars of the state's development and strategic objectives linked to the European Integration Agenda, the Sustainable Development Goals, and the European Green Deal. One of the pillars is a clean environment and sustainable resources. NDS 2030 will be followed by sectoral strategy including Energy strategy and implementation programs. At the local level, each municipality in Kosovo has developed its long-term comprehensive development plan to include all sectors.

The Government Program for the period 2021 – 2025 is the basic document through which Kosovo's Government communicates its vision to the citizens. The program reflects the approach and principles to be followed throughout the governance, and the basic priorities and initiatives that will be taken in all areas including energy. For the energy sector, the goal is to create the conditions for sustainable economic development, through clean and affordable technology and energy. The increasing energy efficiency and the diversity of energy sources will play a key role in achieving this goal. The Government will review the Energy Strategy and draft the National Energy and Climate Plan and review the legal framework, to be in full compliance with the new energy strategy.

Due to its status at the UN, Kosovo is not a direct signatory of the conventions and other international environmental agreements. Kosovo has not participated in or signed the UN Framework Convention on Climate Change (UNFCCC) but it has the responsibility to respond to the requirements as one of the signatories of the Energy Community Treaty. In this context, the Government plans-investments for sustainable development and integrated infrastructure as well as activities to improve the air and natural resources by updating the legal and strategic framework (Kosovo environmental strategy).

The Climate Change Strategy 2018-2027 with its action plan, addresses two components, low emission development, and adaption to climate change effects.

The Spatial Plan of Kosovo, developed by the Ministry of Environment, Spatial Planning and Infrastructure (MESPI), is the key document of the spatial planning sector at the state level built in cooperation with all important sectors of Kosovo's Government including the overall countrywide economic and energy sector.

The Regional Development Strategy for the period 2020-2030 is the basic document that sets out the long-term goals and priorities of the regional development policy and enables the coordination of other sectoral policies for balanced regional socio-economic development in Kosovo.

By the Regional Development Strategy for Kosovo, in the 2022-2027 period, EBRD will support Kosovo in green transition and growth through technical assistance, investment grants, and other applicable EBRD vehicles. As strategic priorities in Kosovo in this period EBRD defines i) developing a more competitive and inclusive private sector to foster economic recovery and growth, ii) supporting green economy transition in Kosovo through a more sustainable energy mix and iii) greater resource efficiency and strengthening regional integration, connectivity, and foreign investment.

Kosovo Energy Strategy (ES) is the key document of energy policy, based on the Law on Energy, that sets out the basic objectives in energy sector development, considering sustainable economic development, environmental protection, sustainable and reliable energy supply to final customers, efficient use of energy, development of new conventional and renewable generation capacities, creation of a competitive market, development of the gas system, and creation of new jobs in the energy sector. Current Energy Strategy of the Republic of Kosovo 2017-2026 (ES 2017-2026) adopted in January 2018, defines the following 5 energy sector objectives:

1) Security of a sustainable, high-quality, safe, and reliable electricity supply with adequate capacities for stable power system operation

2) Integration in the Regional Energy Market

3) Enhancement of existing thermal system capacities and construction of new capacities

4) **Development of natural gas infrastructure**

5) Fulfilment of targets and obligations in energy efficiency, renewable energy sources, and environmental protection.

Integration in the Regional Energy Market (objective no. 2.) means full integration into the regional energy market and implies formal and practical implementation of the Acquis Communautaire on Energy as defined in the Third Package of EU energy legislation (TEP), including the Gas Directive.

One of the measures that should be fully realized before achieving this objective is the approval and implementation of secondary legislation for the implementation of energy sector laws approved from 2016 including the Law on Natural Gas. These measures, among others, are also included in the Program for Energy Strategy Implementation which is a mandatory policy document approved by Government of the Kosovo.

Energy Strategy, as one of the objectives (objective no. 4) set out the **development of natural gas infrastructure, through the connection with gas infrastructure projects in the region of Southeast Europe, especially with the TAP pipeline project and gas ring of the Energy Community**. Given the lack of studies, infrastructure, concrete agreements, etc., the Strategy for the mid-term period envisages some of **the legal and institutional measures** for the achievement of this objective:

1) Development of secondary legislation to implement the Law on Natural Gas

2) Development of institutional capacity for managing activities necessary for the process of developing a natural gas infrastructure

3) Carrying out a feasibility study for the construction of natural gas system infrastructure

4) Developing a plan for the gasification of Kosovo and

5) Preparation and adoption of the necessary model agreements.

New Energy Strategy is in the drafting process under the coordination of the Ministry of Economy (the draft is not publicly available). But the importance of a stable energy supply is one of the key pillars of sustainable economic energy development and the planning of gasification of the country should be seen in this sense as well as in the context of the decarbonization process and the role of natural gas in the energy transition.

4 GAS MARKET

4.1 Potential gas demand assessment

To determine the possibility of introducing natural gas in Kosovo, the future energy demand in Kosovo is made in MAED *Model for Analysis of Energy Demand*. MAED model evaluates future energy demand based on medium- to long-term scenarios of socio-economic, technological, and demographic developments. The MAED model focuses exclusively on energy demand, and even more specifically on demand for specified energy services. When various energy forms, i.e., electricity, fossil fuels, etc., are competing for a given end-use category of energy demand, this demand is calculated first in terms of useful energy and then converted into final energy demand, considering the market penetration and the efficiency of each alternative energy source. The methodology of energy consumption projection in this study is described in detail in the *Gas Demand Assessment*.

The key drivers of energy demand development are economic development and demographics.

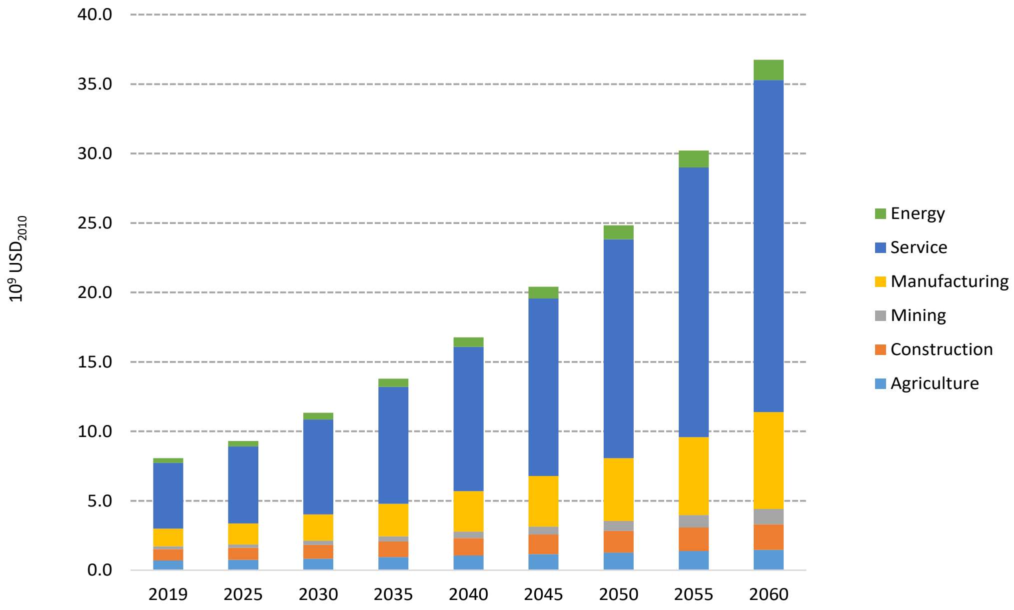
The indicator used in measuring economic development is the Gross Domestic Product per capita (Gross domestic product /cap). In terms of economic development, published data show that the Gross domestic product growth of Kosovo has a positive trend, and it was increasing, on average, 3,6% annually in the period from 2012-2019. Long-term Gross domestic product growth is projected based on an annual growth rate of 4%. However, for the period up to 2025 the Gross domestic product growth rate is calculated separately taking into account the decline of Gross domestic product in 2020 (due to the COVID-19 pandemic) and in line with the Gross domestic product data projections published by the Kosovo Ministry of Finance, Labour and Transfers [1]. Gross domestic product growth projections used in this study are shown in **Table 3**.

TABLE 3 – GROSS DOMESTIC PRODUCT PROJECTIONS

	Unit	2019	2025	2030	2035	2040	2045	2050	2055	2060
Gross domestic product	**[bill US$]**	8,07	9,31	11,33	13,79	16,77	20,41	24,83	30,21	36,75
Gross domestic product gr. rate	**[%p.a.]**		2,43	4,00	4,00	4,00	4,00	4,00	4,00	4,00
Gross domestic product/cap	**US$**	4.526	5.108	6.221	7.653	9.487	11.842	14.907	18.950	24.347

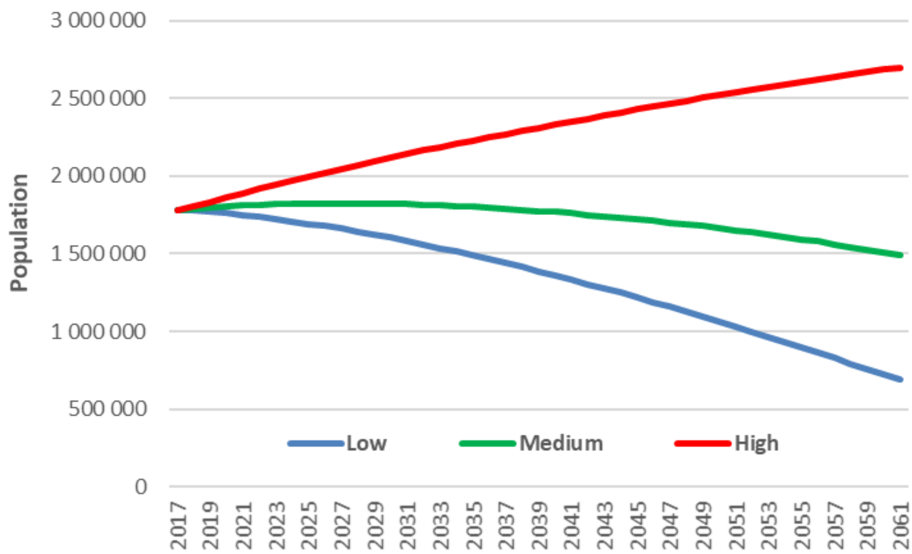
The basic Gross domestic product structure consists of the following three sectors: primary (agriculture), secondary (industry), and tertiary (services). The share of the agriculture sector in Kosovo's Gross domestic product is forecasted to gradually decrease from 8,7% in 2019 to 4% in 2060. The share of the manufacturing sector is expected to grow from 15,7% in 2019 to 19% in 2060, which is closer to developed countries. The share of the service sector will increase from 58,6% in 2019 to 65% in 2060 (**Figure 11**).

FIGURE 11 – GROSS DOMESTIC PRODUCT STRUCTURE PROJECTION



Demographic data for Kosovo and population projections up to 2060 are based on the official data from the *Kosovo Agency of Statistics* (KAS) [2]. There are three options of demographic trends up to 2061 (**Figure 12**). Based on the current data and the information on the situation and the demographic trends in the country, KAS considers that the Medium variant best reflects the future demographic trends in Kosovo.

FIGURE 12 – KOSOVO POPULATION PROJECTIONS 2017-2061



Source: Kosovo population projection 2017-2061, Kosovo Agency of Statistics, December 2017

When forecasting gas demand, under the final energy consumption there are three main consumption sectors that we consider: households, service sector, and industry. Since the energy modelling in the household sector is based on the household unit, it is necessary to determine the number of households in the base year and its projection for future years. The link between the population and the number of households is the number of household members, i.e., "household size". This data is found in the official statistics for the base year, and for the future, it can be projected based on known benchmarks of other countries. Time series of the number of persons per household in developed European countries and countries in transition shows that the number of persons per household decreases as the Gross domestic product per capita increases. This occurs due to the aging of the people and changes in lifestyle in which the shares of the one-member and two-member households are constantly increasing.

In 2019, the average household size in Kosovo was 4,98. The average household size in a rural area (5,1) is derived from the KAS publication "*Energy consumption in households 2015*". Considering the average household size on a national level, a household size for the urban area of 4,80 was calculated. Based on historical trends of household size relative to Gross domestic product per capita in a large number of countries, the average household size in Kosovo is projected to decline from 4,98 to 2,81 in 2060 (**Table 4**).

TABLE 4 – PROJECTIONS OF POPULATION, HOUSEHOLD SIZE, AND NUMBER OF HOUSEHOLDS

	Unit	2019	2025	2030	2035	2040	2045	2050	2055	2060
Population	[million]	1,78	1,82	1,82	1,80	1,77	1,72	1,67	1,59	1,51
Capita/hh	[cap]	4,98	4,66	4,40	4,13	3,87	3,61	3,34	3,08	2,81
Households	[million]	0,358	0,391	0,414	0,436	0,457	0,478	0,499	0,518	0,537

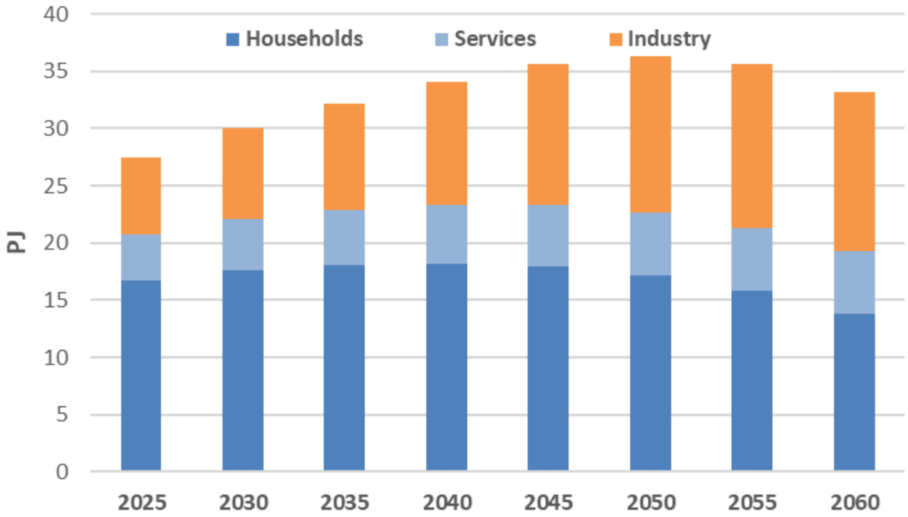
Considering the population and the number of household projections, and the assumed economic development trends, useful energy demand for space heating, hot water preparation and cooking in household sector in Kosovo is projected for urban and for rural households. Considering the technical standard related to the thermal properties (i.e. thermal insulation) of the new buildings, as well as the renovation of the existing housing stock, specific useful energy demand for space heating is expected to decline from 193 kWh/m^2 on average in 2019 to 67 kWh/m^2 on average in 2060. Therefore, the total useful thermal energy demand in households (urban and rural) is projected to grow from 15,4 PJ in 2019 to 18,2 PJ in 2040 and decline after that to 13,8 PJ in 2060.

The methodology for forecasting the energy demand in the service sector is organised with the analogy to the household sector. The main determinant of the energy demand in the service sector is the total floor area of business and public buildings and objects. It is modelled that the floor area of the service sector in 2019 in Kosovo is 3,4 m^2 per capita and it is forecasted that it will grow up to 9 m^2 per capita in 2060. This implies that the total area of the service sector will increase from the current 6 million square meters to 13,6 million in 2060. Also, the increase of the actually heated area is foreseen, as well as reduction of the specific space heating requirements (from 158 kWh/m^2 in 2019 to 61 kWh/m^2 in 2060) as a result of increasing the thermal insulation of buildings. The total useful thermal energy demand is projected to grow from 3,6 PJ in 2019 to 5,5 PJ in 2060.

The future energy demand for useful energy purposes in the industry sector is determined as a product of the projected Gross domestic product of each particular industry group and their projected energy intensities. The thermal energy intensities of the manufacturing sector in Kosovo in 2060 are projected to decline by 57% compared to 2019, which is based on the trends seen in the past in more developed countries, where the decrease of energy intensity occurred due to the structural changes, technically more efficient technologies in industrial processes, and more competitive products with higher prices on the market. The total useful thermal energy demand in industry is projected to grow from 5,9 PJ in 2019 to 13,9 PJ in 2060.

Overall, the total useful thermal energy demand in Kosovo is projected to grow from 24,8 PJ in 2019 to 33,2 PJ in 2060. The forecasted thermal energy demand in Kosovo is shown in **Figure 13**.

FIGURE 13 – FORECASTED THERMAL ENERGY DEMAND IN KOSOVO



4.1.1 Gas for heat

Considering the analyses and forecasts of useful energy demand by the consumption sectors, the energy demand related to thermal uses is forecasted (**Figure 13**). This is the demand that represents the "heat market", i.e., the amount of thermal energy that needs to be met by the final energy consumption of some fuel. Therefore, this is the total potential heat demand, part of which, in the future, could be met with natural gas. In such a case, natural gas would be used for space heating, cooking, and hot water preparation in households, for space heating and potentially cooling in the service sector, and for thermal purposes (both process heat and space heating) in the industry sector.

The forecasted thermal energy demand of Kosovo, if presented in the natural gas consumption[6] potential, would reach 1,1 bcm[7] of natural gas in 2050. Forecasted heat demand in Kosovo, presented in natural gas consumption potential, is shown in **Table 5**.

TABLE 5 – FORECASTED HEAT DEMAND IN KOSOVO PRESENTED AS POTENTIAL NATURAL GAS CONSUMPTION

Consumption sector	Unit	2025	2030	2035	2040	2045	2050	2055	2060
Households	mcm	508	535	549	552	545	522	479	418
Services	mcm	123	137	147	156	163	167	167	167
Industry	mcm	203	239	280	326	373	413	435	423
Total	**mcm**	**834**	**911**	**976**	**1.034**	**1.082**	**1.102**	**1.081**	**1.008**

However, not all of the forecasted thermal demand will be covered by natural gas since the natural gas distribution network may only be developed in the area where the population/consumers density is high enough to justify the investment. Furthermore, some users may not be able or willing to switch to gas due to various technical and economic reasons.

This study assumed that the gas distribution network could only be developed in the urban areas within the municipalities with a population of over 20.000. Additionally, a few municipalities with a lower population were

[6] *Calculated considering the average conversion efficiency of 0.9, and the net calorific value of 36.6 MJ/m³*

[7] *Without natural gas demand for power generation.*

considered due to their high population density and their geographical position that is near to a bigger consumption centre, or on the route of the transmission pipeline.

Considering the findings of the MCC Study [3], it is assumed that up to 50% of urban residential consumers would connect to the gas network, as well as up to 30% of consumers in the service sector, and 70% of industrial consumers.

This approach, together with the assumptions driven by the decarbonisation goals, resulted in projected natural gas consumption in Kosovo reaching 429 mcm in 2045 (in households, services and industry sectors, without gas demand for power generation). This projection of natural gas consumption was used for further analysis. The geographical distribution of the forecasted potential gas demand is presented in **Figure 14**. Note that the gas demand of potential CCGT in Prishtina is not included.

With respect to heating, this assignment considers primarily the supply of natural gas to consumers via gas distribution networks. Alternatively, natural gas could be used as a fuel in district heating plants, i.e., the consumers would be supplied with energy via district heating networks. The Consultant understands a study investigating the possibilities of DH networks development throughout Kosovo is currently ongoing that should investigate those options.

FIGURE 14 – GEOGRAPHICAL DISTRIBUTION OF THE POTENTIAL GAS DEMAND

Note: Sizes of the circles are proportional to the potential gas consumption.

4.1.2 Gas for electricity

Estimation of gas demand for power generation is performed for two distinct periods; up to 2040, and from 2040 to 2060. Estimates until 2040 were taken from REKK[8], that is currently working on the development of several scenarios for the Kosovo's National Energy Strategy up to 2040. One of REKK's scenarios is a GAS scenario, which included the development of two gas-powered generation units (250+129 MW) in operation

[8] *Regional Centre for Energy Policy Research (REKK), Hungary*

from 2028. The 129 MW unit is envisaged only for reserve market. To determine the gas demand for power generation from 2040 to 2060, the Consultant developed detailed Kosovo's power system model using the long-term power system planning tool PLEXOS. Where possible, data for the period 2040-2060 were used based on TYNDP 2020 Scenario Report[9], TYNDP 2022 Draft Scenario Report[10], and World Energy Outlook 2021[11]. Unavailable data, especially for the period after 2050, were estimated up to 2060, which is considered to be the target year for Kosovo to reach decarbonisation goals.

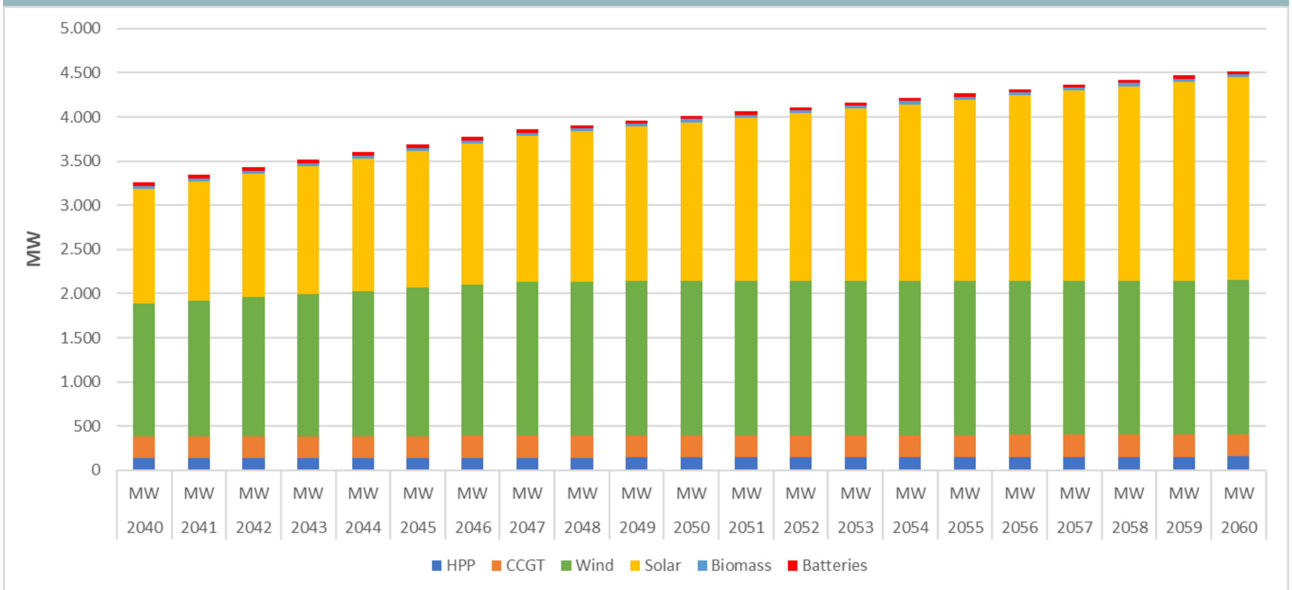
Electricity demand for the period 2040-2060 used in PLEXOS is an output from MAED model, as presented in **Table 6**, where electricity consumption was forecasted considering the decarbonisation targets and the preliminary forecasted natural gas consumption by sectors.

TABLE 6 – KOSOVO ELECTRICITY DEMAND 2040-2060

	2040	2045	2050	2055	2060
Electricity demand [GWh]	6,869	7,430	8,092	9,024	10,193

To meet the growing demand, optimisation resulted in a total of **1.210 MW** of new generation capacity built over the planning horizon (2040-2060). The sequence of newly installed capacities is presented in **Figure 15**. Model chooses to build additional wind and solar capacities due to their lower built costs and no emission costs, resulting in 245 MW of new wind power plants and 1.000 MW of new solar up to 2060. Electricity generation by technology type is shown in **Figure 16**, together with annual imports, exports and demand.

FIGURE 15 – INSTALLED CAPACITIES BY TECHNOLOGY IN KOSOVO FOR THE PERIOD 2040-2060



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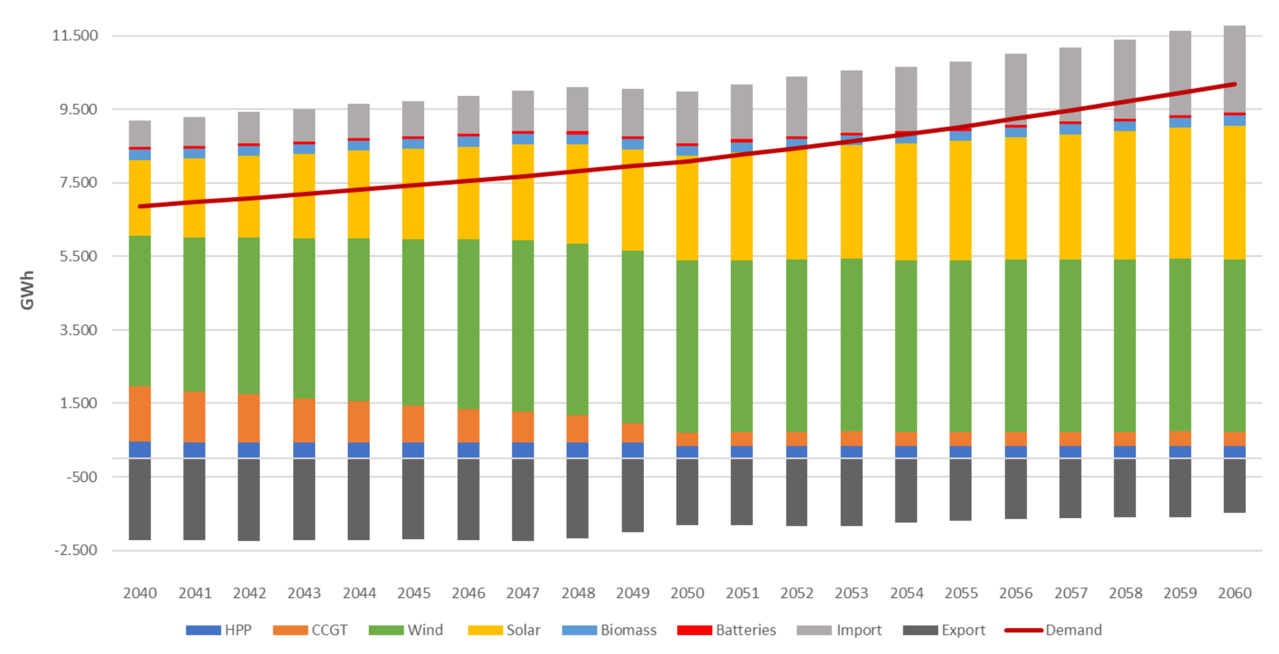
[9] *TYNDP 2020 Scenario Report, ENTSO-E, ENTSO-G, October 2019*
[10] *TYNDP 2022 Draft Scenario Report, ENTSO-E, ENTSO-G, February 2022*
[11] *World Energy Outlook 2021, International Energy Agency, October 2021*

FIGURE 16 – ELECTRICITY GENERATION BY TECHNOLOGY IN KOSOVO FOR THE PERIOD 2040-2060



It can be observed that the total electricity generation increases from 8,5 TWh in 2040 to around 9,4 TWh in 2060. CCGT unit generates from 1.492 GWh in 2040 to approx. 350 GWh in 2050 and after. Total operating hours for the CCGT unit amount between 1.500 and 6.300 hours/year. Using the electricity generation given in **Figure 16**, and REKK's results, electricity generation from CCGT units, and gas demand for power generation for the period from 2028 to 2060 are presented in **Table 7** and **Table 8**.

TABLE 7 – ELECTRICITY GENERATION FROM CCGT UNITS [GWH]

2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
1.786,88	1.739,28	1.692,95	1.647,85	1.638,63	1.629,45	1.620,32	1.611,24	1.602,22	1.571,61	1.541,59
2039	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**
1.512,15	1.483,26	1.382,84	1.309,19	1.200,34	1.123,3	1.019,14	921,42	829,56	733,91	519,09
2050	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**
350,43	371,39	374,17	400,92	368,76	368,07	375,24	382,05	384,47	401,82	378,43

TABLE 8 – GAS DEMAND FOR POWER GENERATION [MCM]

2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
316,9	308,4	300,2	292,2	290,6	289,0	287,3	285,7	284,1	278,7	273,4
2039	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**
268,2	263,0	245,2	232,2	212,9	199,2	180,7	163,4	147,1	130,2	92,1
2050	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**
62,1	65,9	66,4	71,1	65,4	65,3	66,5	67,8	68,2	71,3	67,1

Natural gas demand for power generation steadily declines from 317 mcm in 2028 to 92 mcm in 2049 and remains at about 70 mcm in the period from 2050 to 2060.

4.1.3 Profiles of gas demand

As mentioned previously, considering the forecasted thermal demand and the assumptions that all of that demand would be covered by natural gas, natural gas consumption in Kosovo would reach 1,1 bcm in 2050 (without gas demand for power generation). Gas consumption in the transport sector is not included since most of that consumption is expected to be in the form of LNG for freight transport, and therefore not supplied via pipeline. LNG is expected to be supplied via truck or rail from one of the regional LNG terminals. However, considering the above-mentioned assumptions, projected natural gas consumption in Kosovo could reach 429 mcm in 2045 (without gas demand for power generation). Therefore, the peak load calculations for the hydraulic simulation and dimensioning of the pipeline are made considering the above-forecasted gas consumption for thermal purposes and its seasonality. When calculating the daily loads, the annual forecasted gas consumption of the residential and service sector is divided by 365 days, while the annual forecasted gas consumption in the industry sector is divided by 335 working days (assuming a breakdown due to overhaul, maintenance, collective annual leave, etc.).

When calculating hourly loads of the industry sector, the daily gas consumption is divided by 16 hours, assuming the two working shifts or 16 working hours per day.

Furthermore, when calculating peak hourly loads, the daily gas consumption of the temperature dependant consumers (households and services) is divided by 24 hours and multiplied by the "peak factor", which is the difference between average daily and peak daily demand. According to "*Study on Regulation (EU) 994/2010 on measures to safeguard the security of gas supply*", the peak demand factor for Kosovo is 4,79. It means that the gas demand of temperature-dependent gas consumers, occurring with a statistical probability of once in 20 years, is 4,79 times higher than the average gas demand of temperature-dependent gas consumers in that year.

This calculation resulted in a total peak load for the peak gas consumption in 2045 of 143.177 m^3/h (without gas demand for power generation). Calculated peak loads per consumption sectors are provided in **Table 9** households estimated peak load is 74.923 m^3/h, services sector estimated peak load is 20.817 m^3/h, and industry sector peak load is 47.438 m^3/h.

TABLE 9 – POTENTIAL GAS TRANSMISSION CAPACITY CONSIDERING THE FORECASTED GAS CONSUMPTION IN KOSOVO

Municipality	District	Gas consumption forecast in 2045 (mcm)			Potential capacities in 2045 (m^3/h)		
		Households	Services	Industry	Households	Services	Industry
Pristina	Pristina	35,4	12,2	46,7	19.344	6.685	8.706
Prizren	Prizren	20,6	2,7	14,9	11.261	1.491	2.781
Ferizaj	Ferizaj	8,3	3,5	29,2	4.525	1.893	5.441
Pejë	Peja	10,0	1,8	10,4	5.464	984	1.935
Gjakovë	Gjakova	8,1	1,3	6,5	4.439	708	1.209
Gjilan	Gjilan	9,2	2,2	14,3	5.031	1.200	2.660
Podujevë	Pristina	4,3	1,7	11,0	2.369	932	2.056
Mitrovicë	Mitrovica	8,9	1,6	8,4	4.844	879	1.572
Vushtrri	Mitrovica	4,9	1,6	16,9	2.655	887	3.144
Suharekë	Prizren	2,0	0,7	2,6	1.095	388	484
Gllogoc	Pristina	1,3	0,7	7,1	697	395	1.330
Lipjan	Pristina	1,4	0,9	5,8	751	470	1.088
Rahovec	Gjakova	3,2	0,4	3,9	1.749	201	725
Malishevë	Prizren	0,7	0,5	4,5	382	276	846
Skenderaj	Mitrovica	1,4	0,7	6,5	747	388	1.209
Viti	Gjilan	1,0	0,5	5,2	546	261	967
Deçan	Gjakova	0,8	0,4	1,9	440	231	363
Istog	Peja	1,1	0,3	1,3	584	164	242
Klinë	Peja	1,2	0,4	2,6	675	201	484
Kamenicë	Gjilan	1,1	0,4	3,2	620	224	605
Fushë Kosovë	Pristina	4,2	1,7	7,8	2.272	939	1.451
Dragash	Prizren	0,2	0,3	1,3	120	142	242
Kaçanik	Ferizaj	2,1	0,4	1,3	1.174	231	242
Mitr. e Veriut	Mitrovica	1,5	0,2	2,6	847	112	484
Shtime	Ferizaj	1,4	0,2	0,6	787	89	121
Obiliq	Pristina	1,1	0,4	3,9	625	201	725
Hani i Elezit	Ferizaj	0,5	0,3	33,3	296	164	6.206
Mamushë	Prizren	1,1	0,1	0,6	581	82	121
Total		**137,0**	**38,1**	**254,3**	**74.923**	**20.817**	**47.438**
		429,4			**143.177**		

4.1.4 Load management and storage

Generally, natural gas consumers can be divided into three categories:

anchor consumers (large industry, power plants, etc.)

industrial consumers, and

consumers on gas distribution system (households and service sector).

Depending on the profile of the anchor consumers, some seasonality in gas consumption can be observed (for instance if CHP[12] Plants are numerous). Industrial consumers may show some seasonality in gas consumption pattern but generally they operate at a constant rate throughout the year to maximize available production capacity. The main drivers of gas consumption in industry are processes which require natural gas (furnaces, raw gas input, turbines, etc.) are insensitive to weather seasonality. On the other hand, consumers connected to the gas distribution network, i.e. the households and services sector show most pronounced seasonality in their consumption patterns. Gas consumption of households and service sector is roughly 90% seasonal as it is related to space heating needs. These needs are closely related to the outside air temperatures.

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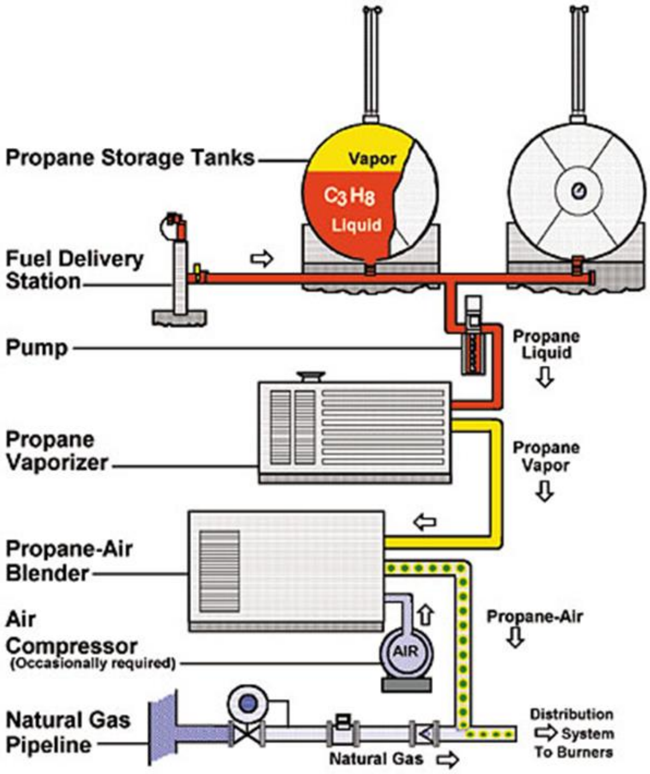
[12] *Combined Heat and Power plants*

The distribution consumption consists of two main parts. One is fixed gas consumption which entails hot water preparation and cooking. The other is a variable gas consumption which entails space heating. It is in the Consultant's experience that there is an absolute correlation between outside temperature and heating intensity and an undeniable causation of cold weather causing people to heat their homes. The experience stems from experiences in energy balancing, energy statistics, and energy demand forecasting. The fixed part of the consumption is at 10% of the total annual natural gas demand of the distribution network, while the variable consumption accounts for the remaining 90%, varying depending on the season. Considering the structure of the forecasted gas demand for Kosovo, about ¾ of the forecasted gas consumption is expected to be constant. However, due to the relatively high peak demand factor for Kosovo, peak gas demand might be substantially higher than the average gas demand (see Chapter **4.1.3**).

Since the gas consumption has a seasonal character and isn't constant throughout the year, a screening of different peak shaving and seasonal storage measures has been carried out. One of the solutions for peak shaving for industrial and commercial consumers is a propane-air system. Propane-air, also called LPG-Air or SNG, is essentially synthetic natural gas that is formed by mixing vaporized propane or LPG with air. Once mixed, it forms a homogeneous mixture that can be used as a direct replacement for natural gas in combustion applications. A typical propane-air peak shaving plant consists of an LPG storage facility, truck unloading station, transfer pumps, propane vaporizers, air compressors, propane-air mixer, gas flow rate and calorific value measurement device, and system controls (**Figure 17**).

FIGURE 17 – SCHEME OF PROPANE-AIR PEAK SHAVING PLANT



As mentioned, LPG tanks/storages could be used as dual-fuel capability for the industrial and larger commercial consumers, while is not practical to use them for distribution systems. The use of dual-fuel capability for boiler houses in the industry and larger services will often be the simplest solution for peak shaving. One of the barriers to the use of dual-fuel is the difference in fuel prices. Hence, the use of interruptible consumers[13] needs to be regulated on a contractual level to clarify the obligations of the gas company.

Line packing of gas transmission system until the pipeline reaches full potential in the later stages of the project utilisation would be from the investment point of view the cheapest solution (the price of balancing gas is another issue). It might be a solution for the fast daily peak shaving. This means that TSO could use the internal storage of the pipeline by reducing the pipeline pressure to a minimum allowable level. To control the line packing a SCADA[14] system needs to be implemented.

Also, solutions like CNG and/or small-scale LNG storage facilities could be considered for peak-shaving, depending on the economic feasibility of the available options, on a case-by-case basis.

On the other hand, there is the concept of nudging customer behaviours to shift loads outside of peak demand periods. This concept of load management (or demand response) is utilized in the management of the electricity grid. However, load management is a tool that historically has not been utilized in the management of the natural gas demand. The use of a pricing structure with high incentives for the large consumers to use gas during periods with low consumption, and high prices respectively during the peak consumption periods will normally be the least cost solution for reducing peak loads. For individual consumers connected to the gas distribution network, a higher tariff during the winter months would encourage energy savings, either as reduced temperature or comfort or by investing in insulation to reduce heat losses.

To analyse the potential need for underground gas storage in Kosovo, the assessment of the required storage volume and the daily withdrawal capacity has been carried out. The assessment is carried out considering the forecasted gas demand assuming that the gas supply will be contracted at a level of average expected annual gas consumption throughout the year. The UGS model applied accounted for the variable seasonal gas consumption, optimizing the storage to be filled during the summer and emptied during winter. The historic Heating Degree Days (HDD) index information for Kosovo was taken from the BizEE Degree Days.net and linked to the forecasted natural gas annual consumption. Considering the structure of the forecasted natural gas consumption, this resulted in the potential storage needs peaking at 88 mcm in 2045, with a maximum withdrawal capacity of 1,77 mcm/day. Since there is no underground gas storage in Kosovo, the virtual storage sub-lease option could be implemented. The virtual storage sub-lease option means that the local gas supplier creates a sub-lease storage agreement with suppliers using existing gas storage capacities in the region. The price of that gas will be a gas market price increased for the expected storage costs. The supplier's benefit in that deal is the fact that the gas is sold at the market price increased by the storage fee, but realized without the actual storage use and transport costs to and from the storage facility. Such an agreement is common gas market practice. This option, together with other load management options that do not require any investment (dual-fuel, tariff incentives, line-pack, and similar) would represent the most feasible and recommended load management option for Kosovo.

4.2 Gas supply assessment

In Kosovo, currently, there is no functional gas infrastructure and no connections to the regional gas network. Since there is no production nor proven reserves of natural gas in Kosovo, the import of natural gas is the only gas supply option for Kosovo.

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[13] Consumers with interruptible gas transmission capacity that may be interrupted by the transmission system operator in accordance with the conditions stipulated in the transport contract. Interruptible consumers pay reduced gas transportation charges in return for the flexibility they provide to the system by agreeing to be interrupted during the periods of high gas demand.

[14] Supervisory Control and Data Acquisition

4.2.1 Gas supply route options

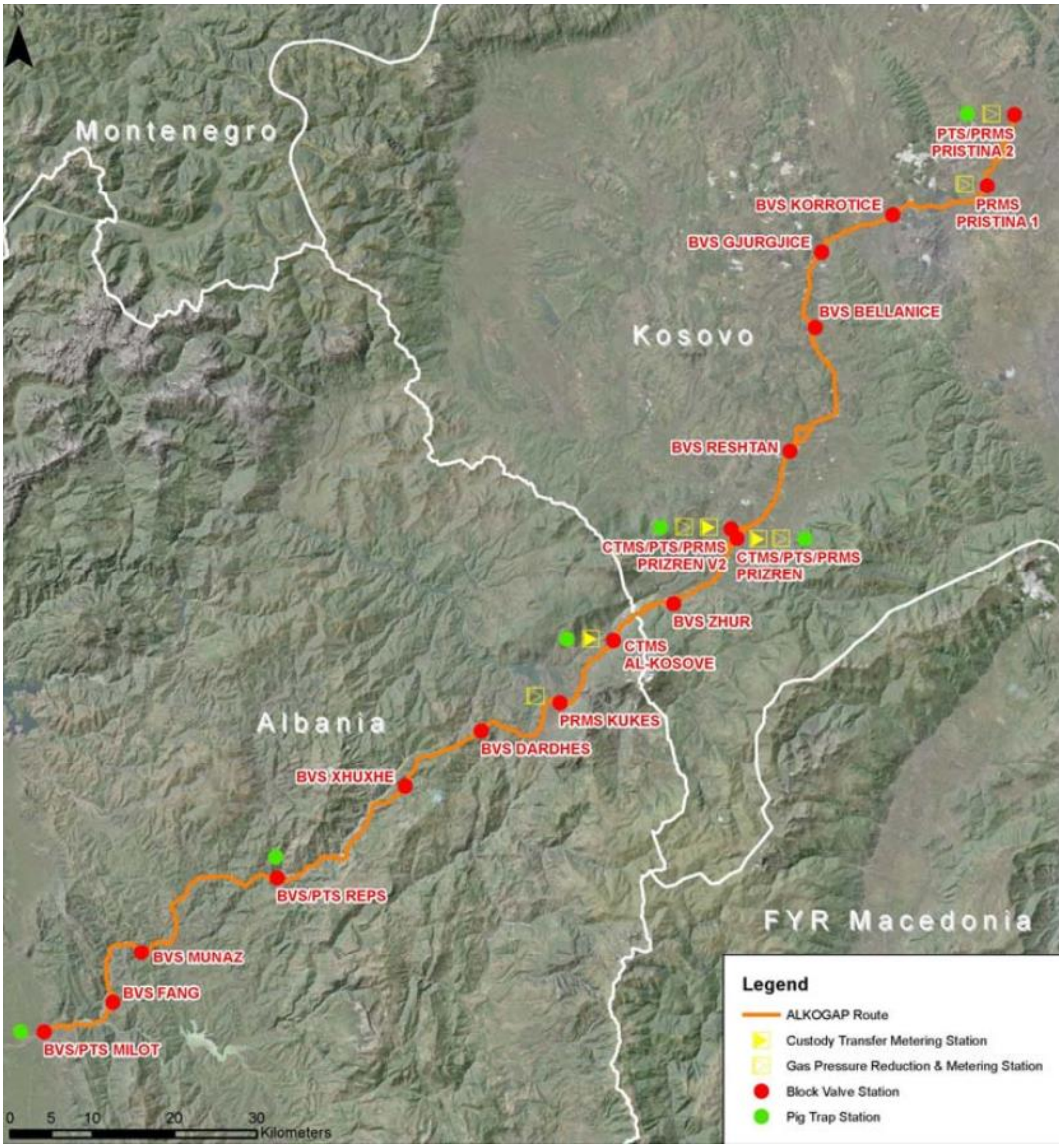
In terms of gas supply, currently, there are two options for gas import in consideration. One option is gas supply from North Macedonia via the North Macedonia-Kosovo gas pipeline (SKOPRI pipeline). The other option is gas supply from Albania via Albania-Kosovo Gas Pipeline (ALKOGAP). Should these options not be successfully implemented, Kosovo could potentially be supplied with natural gas in the form of compressed natural gas (CNG) or liquefied natural gas (LNG) delivered via road or railway transport. The sources of LNG in this case could be existing and planned LNG terminals in the region (Croatia, Greece, and Albania), while CNG could be delivered from the operational CNG filling station in North Macedonia, or possible new CNG facilities.

FIGURE 18 – POTENTIAL NATURAL GAS SUPPLY ROUTES

The North Macedonia-Kosovo gas interconnection (SKOPRI), together with the planned gas interconnection Greece-North Macedonia, would enable gas supply from the Caspian region via Trans Adriatic Pipeline (TAP), as well as LNG supplies from the LNG terminal in Greece. The start of construction is expected in the second quarter of 2022, while the commissioning of the Greece-North Macedonia interconnection is expected in 2024. Note that for more significant gas deliveries to Kosovo, which are projected in later years, it will be necessary for North Macedonia to complete its western branch of the gas ring (via Bitola). Out of Western ring sections; Skopje-Gostivar section is currently approx. 70% completed, tender for construction of the section Gostivar-Kichevo is expected this year. The remaining two sections (Kichevo-Ohrid and Ohrid-Bitola) are expected in the following years. Overall completion of the western section of the North Macedonia gas ring is expected in late 2025 or early 2026. Considering the current level of development of Kosovo's gas infrastructure, the Consultant considers this is sufficient.

Albania-Kosovo Gas Pipeline (ALKOGAP) (**Figure 19**) is the gas transmission pipeline which aims to establish a new supply route for the natural gas transported from the Caspian Region via the Trans Adriatic Pipeline to Albania, and then in a northeast direction through Albania towards Kosovo. ALKOGAP would connect to the planned Ionian-Adriatic Pipeline (IAP). Since IAP would be bidirectional, it could provide gas supply from TAP, and also natural gas supply from the Croatian LNG terminal on the island of Krk. The routes of the Trans Adriatic Pipeline and the planned Ionian-Adriatic Pipeline are shown in **Figure 18**. The route of the Albania-Kosovo Gas Pipeline is shown in **Figure 19**.

FIGURE 19 – ALKOGAP CORRIDOR



Source: Pre-feasibility Study for Albania to Kosovo Gas Pipeline

According to the available information, the Environmental Impact Assessment and Basic design for the sections of IAP in Croatia have been completed, and some sections also have the main design completed. For the Albanian and Montenegrin sections, preliminary design and ESIA were completed in November 2021.

The pre-feasibility study for ALKOGAP was completed in 2018. According to available information, no further development activities are ongoing. The Consultant has no recent information on the expected dynamics of the final investment decision, tender for the construction, and envisaged start of the operation. However, 2026 start of operation for IAP and 2027 for ALKOGAP are reported by Energy Community[15].

[15] https://www.energy-community.org/regionalinitiatives/infrastructure/PLIMA/Gas16.html
https://www.energy-community.org/regionalinitiatives/infrastructure/PLIMA/Gas13.html

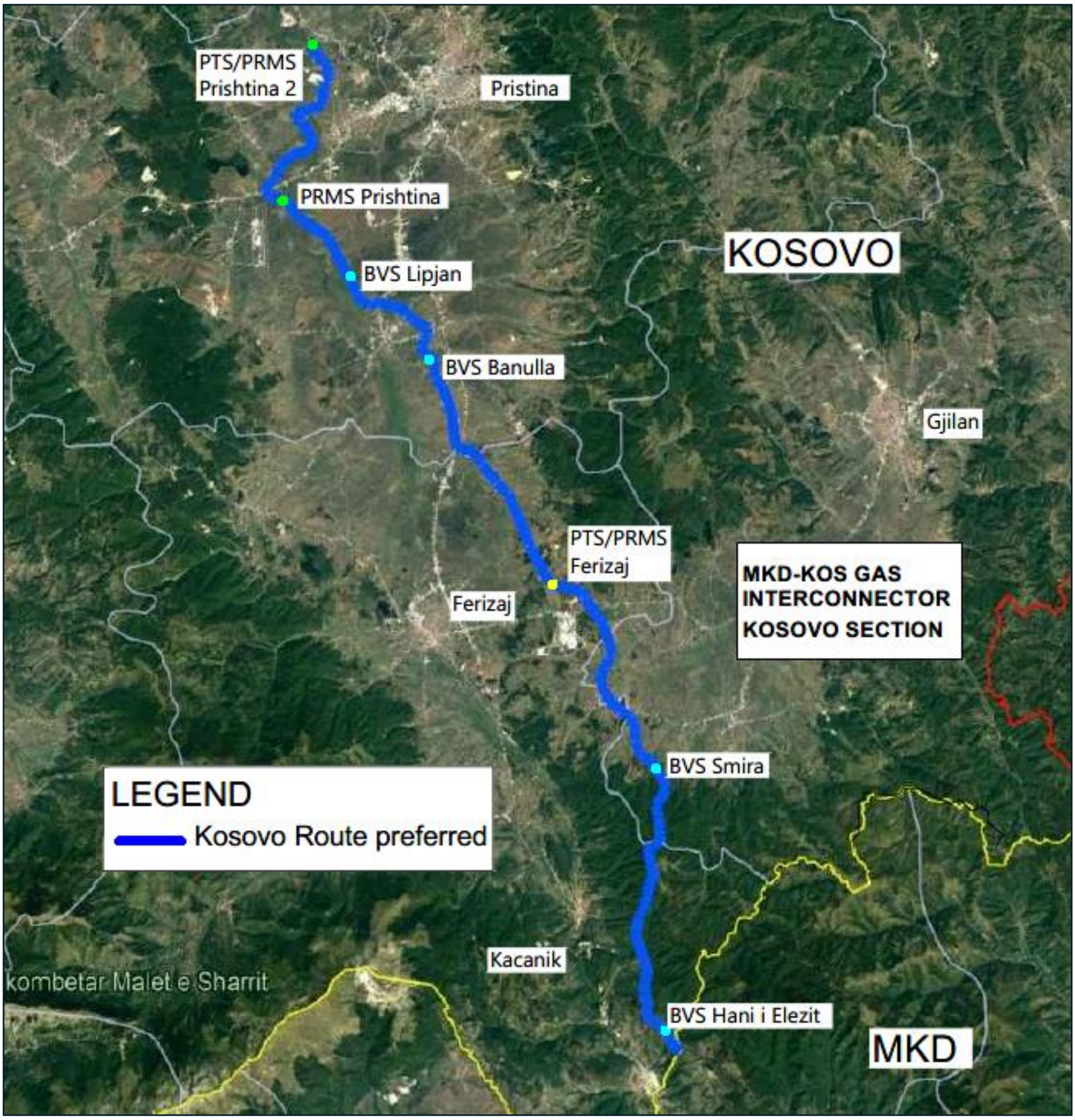
Considering the potential gas demand projections for Kosovo provided in the Gas Demand Assessment, both supply routes have sufficient capacity for natural gas supply. However, considering the described status of the prerequisite infrastructure development in the region, the Consultant notes that the North Macedonia-Kosovo gas interconnection will likely be possible much earlier than the ALKOGAP. Furthermore, although the length of the pipeline from the North Macedonian border to Prishtina is comparable to that of the Albanian border, the length of the pipeline that needs to be built in Albania to connect IAP makes a big difference between the two supply options for Kosovo. Also, ALKOGAP route terrain is more difficult. Therefore, considering the pipeline length and corresponding investment costs, the connection to the North Macedonian gas system is much more realistic option for Kosovo gas supply.

Once the relevant interconnections are completed, Kosovo is likely to be a part of a large and integrated SEE gas system and gas suppliers active in Kosovo will be also able to access a number of regional gas hub/exchanges, with potential benefits both in terms of price and security of supply.

AE Prefeasibility Study - 2019/2020, Kosovo Compact Energy Sector examined three natural gas supply options to meet the projected gas demand in Kosovo and identified the option best suited to meet the country's projected energy needs. Gas Interconnector Pipeline Skopje-Prishtina with a gas transmission and distribution network development in Kosovo is identified as the least cost option to serve the projected gas demand.

The main purpose of the construction of North Macedonia-Kosovo gas pipeline interconnection arises from the strategic commitment of the Governments of the Republic of North Macedonia and Kosovo to achieve a higher level of the overall functionality of the energy system in the country and to provide conditions for significantly greater infrastructure and economic integration with the neighbouring countries and the remaining European countries. The total length of the North Macedonia-Kosovo gas pipeline is approximately 101 km, of which 26 km in North Macedonia and 75 km in Kosovo. The envisaged route of the North Macedonia-Kosovo gas interconnection is shown in **Figure 20**.

FIGURE 20 – NORTH MACEDONIA-KOSOVO GAS INTERCONNECTION ROUTE



Source: North Macedonia-Kosovo gas interconnection identification and technical assessment of alternatives for the pipeline route, 2021

A gas transmission pipeline from Skopje to Prishtina would establish a gas supply route for Kosovo. This in turn would enable the start of the gasification of Kosovo. From the North Macedonian perspective, the establishment of this route would increase the gas transmission volumes through the North Macedonian gas transmission system, thus potentially benefit the transmission tariffs, thus further increasing the competitiveness of natural gas.

4.2.2 Gas infrastructure, developments and sources of natural gas in the region

In terms of existing gas interconnections, North Macedonia has one gas interconnection with Bulgaria (commissioned in 1997) and is supplied with Russian gas through the 20”, 98 km long gas pipeline that carries gas through the interconnection point of Zhidilovo at the Bulgarian border. Commercial reserves of natural gas in North Macedonia have not been declared.

Currently, the main natural gas consumer in North Macedonia is the TE-TO power plant in Skopje. During the winter peak demand months, it uses almost the full capacity of the Zhidilovo-Skopje pipeline. Therefore, North Macedonia is striving to connect major gas demand centres or anchor loads through a transmission network that can tap into Europe’s priority transnational pipelines: TAP, TANAP, IAP, and TurkStream. As a result, National Energy Resources (NER) is implementing several pipeline projects in the country including a gas connection with Greece. *Natural Gas Interconnector Greece-North Macedonia Feasibility Study (2019)* assesses the technical, environmental, and economic feasibility of the extension of the gas transmission system of Greece to the Greece/North Macedonia border, and further to Negotino in North Macedonia. The 30” diameter pipeline with a design pressure of 68 bar has a length of approximately 55 km in Greece, while the 28” diameter pipeline with a design pressure of 68 bar has a length of approximately 68 km in North Macedonia.

Considering the demand forecast, and the maximum capacity (0,8 bcm) of the existing 20” pipeline carrying Russian gas for North Macedonia via Bulgaria, the development of the Gas Interconnector Greece-North Macedonia is a necessity to cover the future gas demand, both for North Macedonia and Kosovo.

FIGURE 21 – EXISTING AND PLANNED GAS INFRASTRUCTURE

Source: ENTSO-G & Gas Infrastructure Europe

Trans Adriatic Pipeline (TAP), being part of the so-called Southern Gas Corridor, was commissioned in November 2020 to provide access to Azeri gas sources. TAP starts at the border of Turkey and Greece, where it connects with TANAP. The total length of the pipeline is 878 km with a design pressure of 95 and 145 bar (offshore section) and a diameter of 48” and 36” (offshore section). The pipeline is to deliver new gas supplies from Azerbaijan through Greece and Albania, crossing the Adriatic Sea to Italy. The initial capacity is 10 bcm, and according to current supply contracts, capacity is booked for 25 years, with 8 bcm to Italy and 1 bcm respectively to Greece and Bulgaria. However, there is the possibility to expand the capacity up to 20 bcm with the additional compressor stations, one in Greece, and one in Albania.

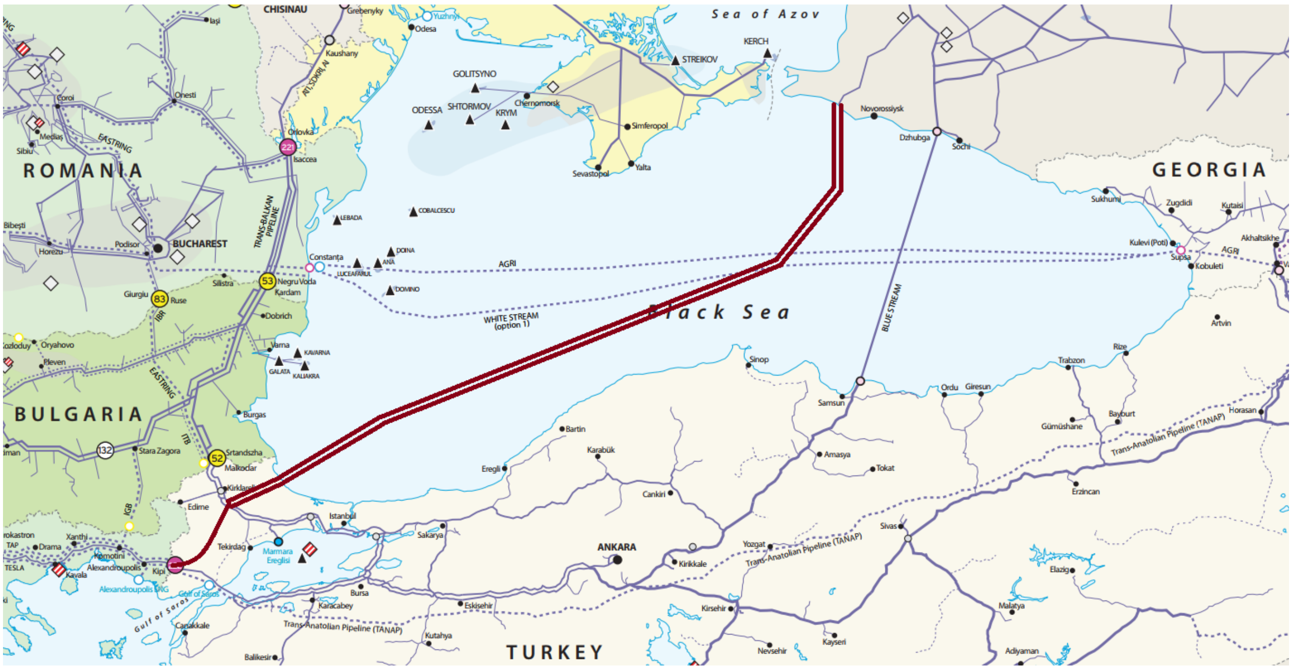
The backbone of the Southern Gas Corridor is the Trans Anatolian Natural Gas Pipeline (TANAP), commissioned in 2018. Its current technical capacity is 16 bcm per annum, planned to increase to 24 bcm in 2023 and to 31 bcm in 2026 (most of which is reserved for Europe).

FIGURE 22 – THE ROUTE OF TANAP

Gas flows from Azerbaijan to Italy might result in decreasing prices on the Italian gas hub PSV (*Punto di Scambio Virtuale*). The importance of the TAP for southeast Europe will increase once the interconnector between Bulgaria and Greece is finalised (expected in mid-2022), enabling delivery of Azerbaijan gas in the region still largely dependent solely on imports from Russia.

TurkStream pipeline, commissioned in January 2020, directly connects the large gas reserves in Russia to the Turkish gas transportation network.

FIGURE 23 – THE ROUTE OF THE TURKSTREAM PIPELINE



The pipeline is a dual pipeline system (both pipes 32" diameter), of which one string is reserved for Turkey, while the other one is for Europe. The technical capacity is 31,5 bcm (15,75 bcm to Europe, 15,75 bcm to Turkey). This pipeline substitutes gas transit through Ukraine and thus brings diversification in terms of supply routes to the region, but it does not provide diversification of gas sources to the region since it is Russian gas.

Kosovo could be supplied with this gas via Bulgaria and North Macedonia. However, as mentioned earlier, there is a bottleneck regarding the existing infrastructure and interconnection point at Zhidilovo.

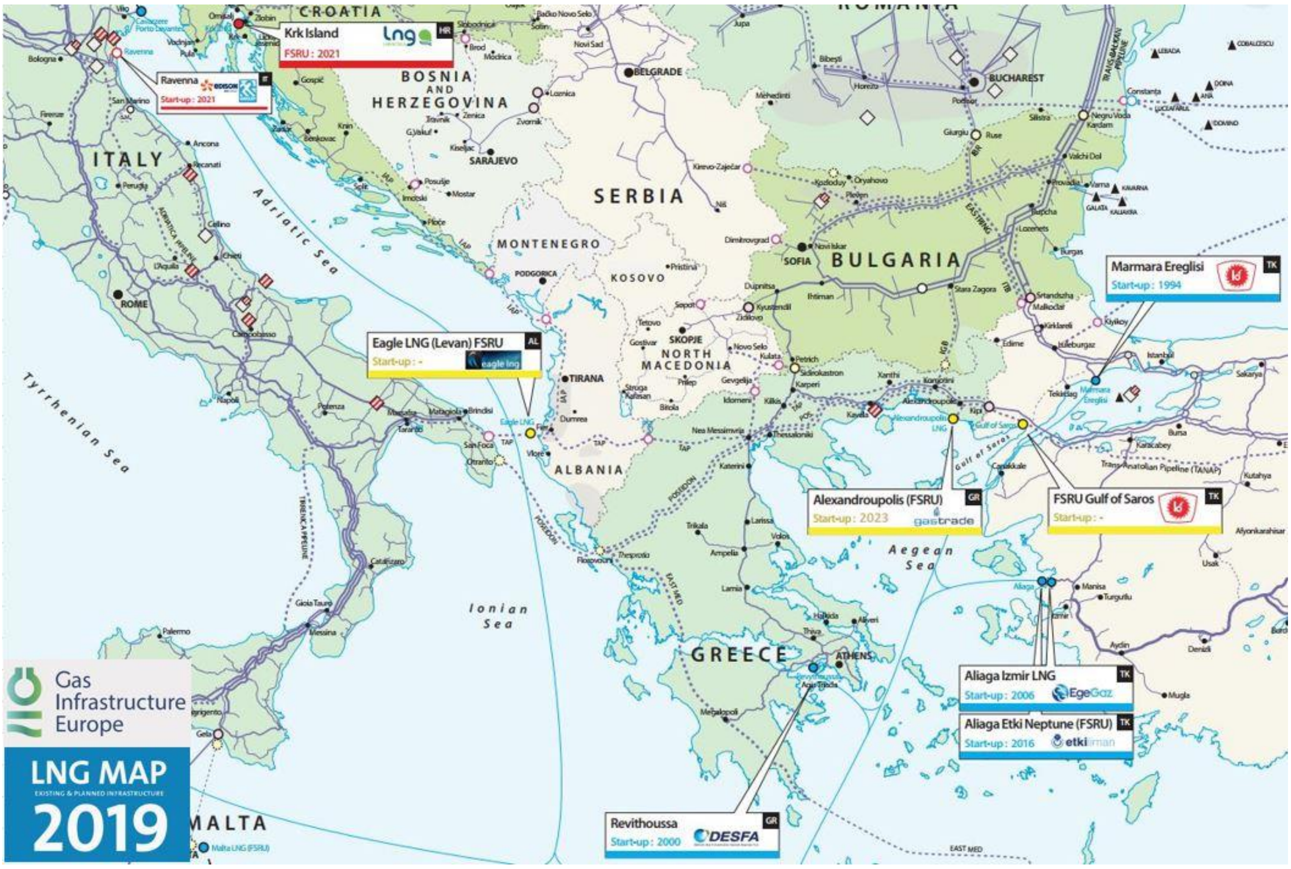
4.2.2.1 Potential LNG supply sources

In terms of the LNG supply, the existing LNG terminal in Greece, near the city of Athens on an island called Revythoussa, has a regasification capacity of 7 bcm annually. The planned new LNG terminal Alexandroupolis in Greece is planned to have a capacity of 6,1 bcm/y. It is expected to be operational by the end of 2023.

The Krk LNG terminal in Croatia began operating in January of 2021. Its annual regasification capacity is 2,6 bcm/y. The regasification capacity increase is planned for an additional 4,4 bcm, reaching a total regasification capacity of 7 bcm/y. This terminal could serve as a source of gas supply for Kosovo if IAP would be developed.

The Eagle LNG terminal (FSRU) in Albania was planned to be located near Levan, in Fier County. This project appears to be cancelled, however, in 2021, the Ministry of Infrastructure and Energy of Albania and Excelerate energy, along with ExxonMobil, signed an MOU to conduct a feasibility study for the potential development of an LNG import terminal in the Port of Vlora, Albania. If implemented, this terminal could also serve as a source of gas supply for Kosovo via ALKOGAP, or virtually via North Macedonia-Kosovo gas interconnection. However, no details about this project are currently available.

FIGURE 24 – LNG INFRASTRUCTURE

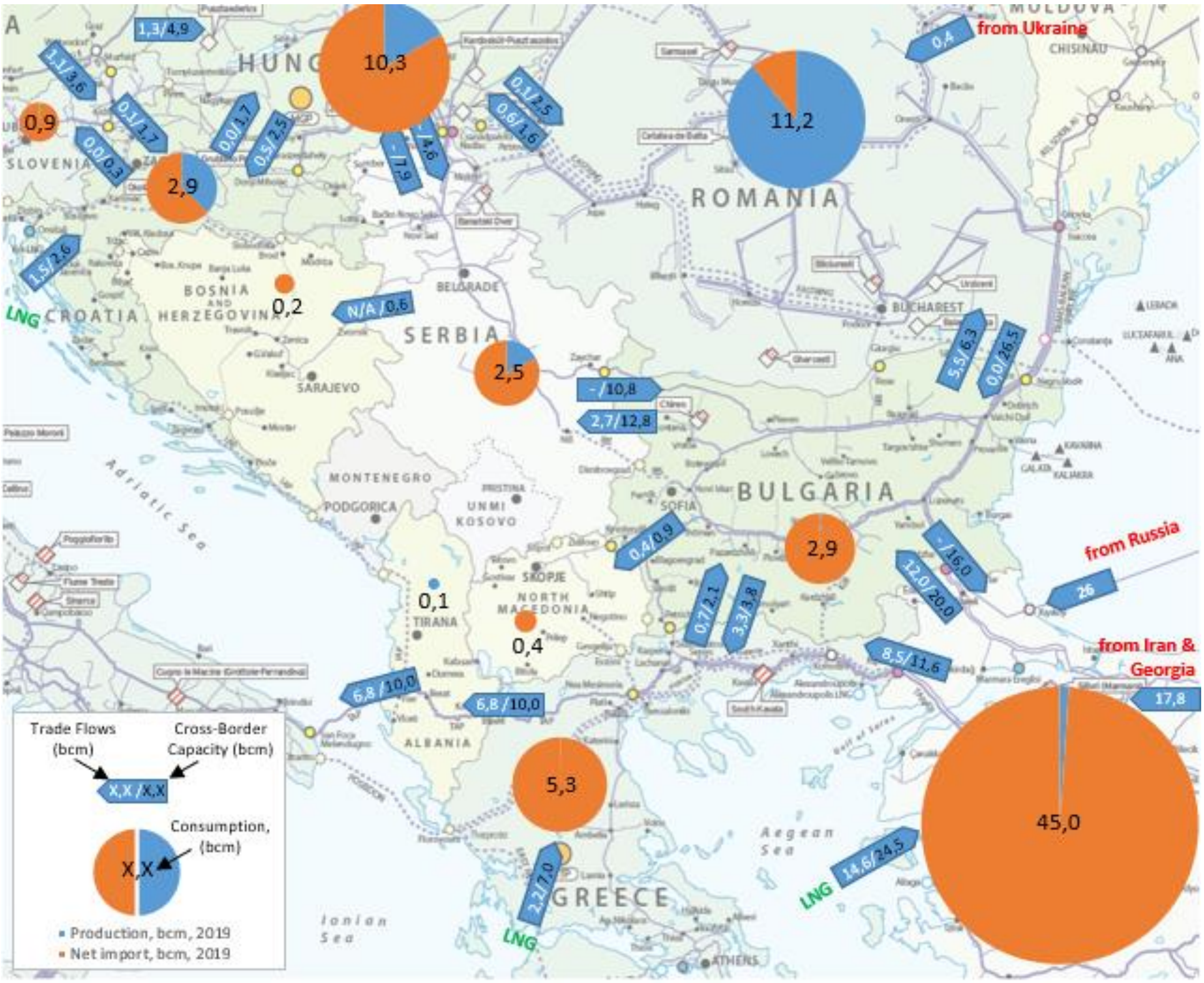


Source: Gas Infrastructure Europe

4.2.3 Natural gas trade and reserves

In terms of gas trade flows in SEE and the wider region, roughly 50% of the natural gas quantities in 2021 came from Russia via TurkStream pipeline, while the rest of the gas supplied to the region came from LNG (~33%) and from the Middle East (~17%). A graphical representation of the gas trade flows in the region in 2021 is shown in **Figure 25**. The Figure also provides information on the currently installed cross-border capacities, national gas consumption, and structure thereof (net imports and domestic production). Installed cross-border capacity in the region is sufficient for delivery of additional gas quantities for Kosovo.

FIGURE 25 – NATURAL GAS TRADE FLOWS, CROSS BORDER CAPACITIES, DOMESTIC CONSUMPTION AND PRODUCTION IN THE REGION IN 2021[16] (MCM)



Source: Gas Infrastructure Europe, ENTSO-G, Eurostat, Gas Trade Flows data service, IEA, February 2022

In terms of natural gas reserves in Europe, the largest natural gas reserves are in Norway (~1400 bcm at end of 2020). In the SEE region, the largest natural gas reserves are in Romania. Proved natural gas reserves in Romania at the end of 2020 amounted to 100 bcm (~2.5% of total Europe), which gives the reserves to production ratio[17] of 9.1. There are also some smaller amounts of natural gas reserves in Croatia, Serbia, Bulgaria, and Greece. Natural gas production in SEE countries and the share of gas production in total natural gas consumption are shown in **Figure 26**.

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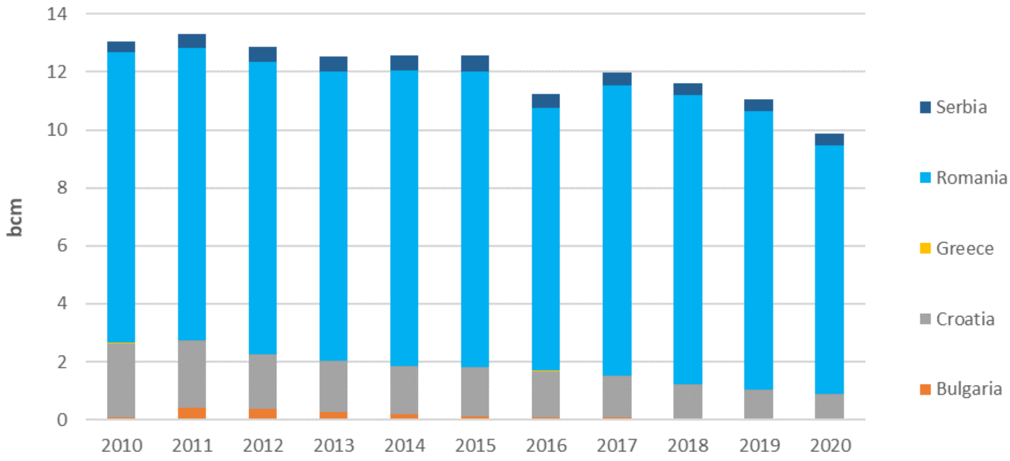
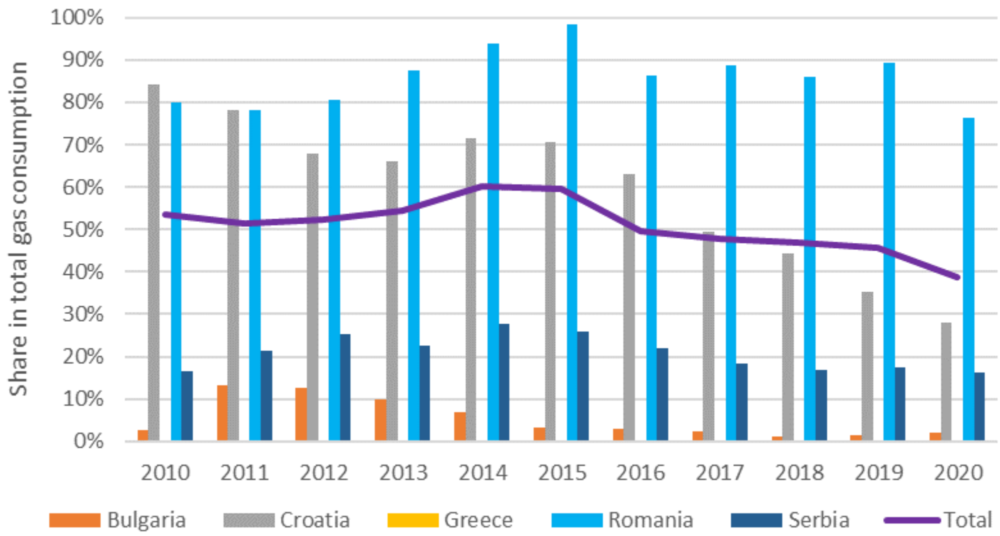
[16] *Production and consumption data are from 2019 (pre-COVID year)*

[17] *Reserves to production ratio is the ratio of the reserves remaining at the end of the year divided by the production in that year.*

FIGURE 26 – NATURAL GAS PRODUCTION AND SHARE IN CONSUMPTION IN SEE REGION





Source: Eurostat, Energy balance sheets, January 2022 Edition

Considering the proven natural gas reserves in the region and worldwide, the availability of natural gas is not the issue for the gasification of Kosovo or even the region. The key issue is whether there will be sufficient infrastructure investment to bring the gas to the Kosovo market, including transmission and distribution gas pipelines, and the economics of those investments.

The analysis of the current natural gas supply balance for the SEE region (**Figure 25**) shows that about ¾ of the natural gas quantities entering the region is of Russian origin. More specifically, Bulgaria and Greece, the countries from where gas is envisaged to arrive to Kosovo were in 2021 supplying 75% and 38% of their needs with Russian sourced natural gas[18]. The existing gas infrastructure enabled that up to 70% of the Russian gas be replaced by increasing gas imports from the Caspian region and via existing LNG terminals. With the additional LNG import capacities that will be available after the commissioning of the Alexandroupolis LNG terminal in Greece (**Figure 24**), planned in 2023, it will be possible to compensate for the total disruption of gas supplies from Russia to the region. Furthermore, if we include plans to increase the capacity of the Trans Anatolian Natural Gas Pipeline (TANAP) from 16 to 24 bcm in 2023 and to 31 bcm in 2026, as well as the possibility to expand the capacity of the Trans Adriatic Pipeline (TAP) up to 20 bcm, the total disruption of the natural gas supply from Russia to the SEE region shouldn't be a problem.

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[18] *Eurostat*

4.3 Gas pricing – tariff considerations

In this section we summarize key considerations that should be taken into account when devising gas tariffs. Considerations are given separately for transmission and distribution activities. More details can be found within the Tariff study submitted within this assignment. In terms of responsibility for metering, billing and collections, it resides with the gas TSO or DSO.

4.3.1 Gas transmission tariffs

The Tariff study provides a detailed analysis of the gas transmission tariffs. In this chapter, we summarize the main suggestions regarding the structure of gas transmission services and tariffs.

Tariffs for network users should be **non-discriminatory** and set separately for every entry point into or exit point out of the transmission system (network charges cannot be calculated based on contracted paths). In one extreme, this implies that each entry point into the system and each exit point could have different gas transmission tariff. On the opposite end, it is possible to group similar entry and exit point resulting in effect in a postal stamp type gas transmission tariff.

Regarding the services, the transmission system operator should provide to system users:

- both **firm** and **interruptible** third-party access services. The price of interruptible capacity should reflect the probability of interruption.
- both **long** and **short-term services**.

The costs of transmission services should be recovered primarily from **capacity-based** transmission tariffs. In addition to capacity-based tariffs, a portion of the transmission service revenue may be recovered by **commodity-based tariffs**. A commodity-based tariff is a flow-based tariff. It intends to cover the cost mainly driven by the quantity of gas transported through the network (for example compressor fuel costs).

4.3.2 Gas distribution tariffs

Regulation regarding gas distribution tariffs is less prescribed than transmission network regulation. The principles used for setting the allowed revenue should be the same as in the case of gas transmission network, and the Consultant proposes that the Energy Regulatory Office of Kosovo use revenue cap approach.

In terms of tariff structure, the same principle as in the gas transmission applies: a fixed and variable charge need to be defined. While it is common practice among gas DSO to collect larger share of revenues from the variable charge, it would be more appropriate to collect larger share of revenue from fixed charge: The rationale is that gas distribution costs are, as in the case of gas transmission, mostly fixed. Therefore, the Consultant proposes the following gas distribution tariff structure:

Component based on consumer's capacity.

Component based on consumer's actual withdrawal, ie. based on energy consumed. It is common practice among gas DSOs that this component is based on the annual quantity of gas consumed.

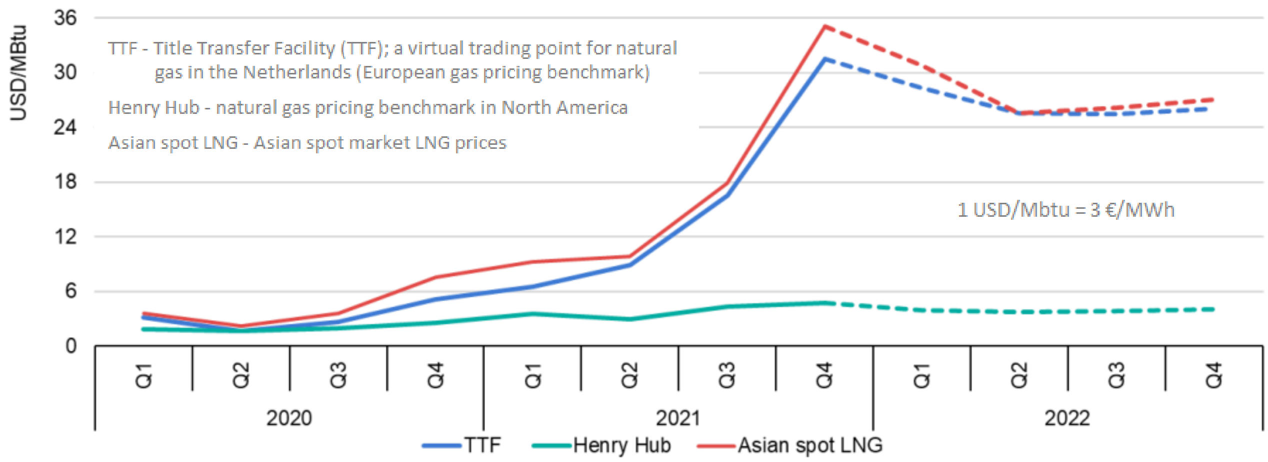
Administrative charge to reflect administrative and metering costs

Connection costs reflect the cost of connecting new consumers to the network. Connection costs can be deep, shallow, or some combination in between. While deep connection costs imply that the consumer pays higher amounts for connecting, shallow costs imply that consumers are charged only a fraction of the total costs while the remaining amount is socialized. To incentivize the gas consumers to switch to gas, the Consultant suggests a shallow connection charge mechanism is applied to Kosovo. To reduce uncertainty, a fixed, predetermined and relatively modest connection charge should be administered for small and medium sized consumers.

4.3.3 Gas prices

In 2021, European wholesale gas prices were impacted by the disturbances on the gas market, which has led to a significant increase in natural gas prices. According to the latest available short-term forecasts (IEA), European and Asian natural gas prices will remain at relatively high levels in 2022 (**Figure 27**).

FIGURE 27 – SHORT-TERM NATURAL GAS PRICE FORECASTS

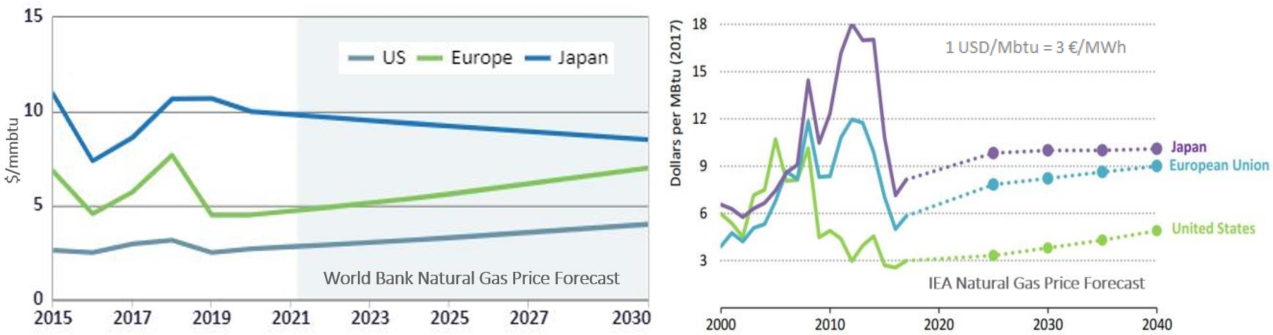


Source: IEA Gas Market Report, 2022

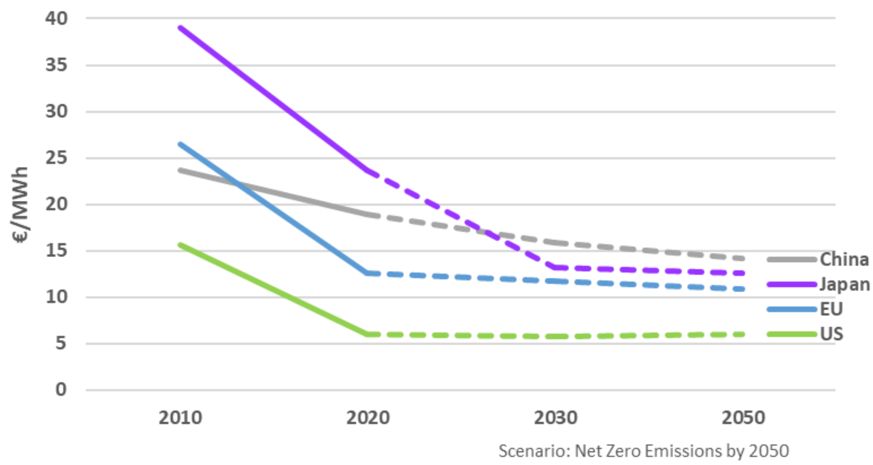
Note that the above forecasts are published before the Russian invasion of Ukraine, which additionally elevated gas prices.

According to IEA World Energy Outlook 2021, the future growth in global gas trade will come mostly from LNG (up to 70% of traded volumes by 2050), which facilitates the convergence of natural gas prices in key regions. As shown in **Figure 28**, forecasted natural gas prices on global markets converge and in the long term are expected to return to pre 2021/2022 spike levels and gradually grow or remain stable in the coming decades. In case of realisation of zero carbon goals, gas prices are expected to decline (note that the graphs do not catch the price spike in winter 2021/2022).

FIGURE 28 – LONG-TERM NATURAL GAS PRICE FORECASTS



Source: World Bank 2021 & IEA World Energy Outlook 2018



Source: IEA World Energy Outlook 2021

The long-term natural gas price forecasts under the different World Energy Outlook scenarios are shown in **Table 10**. Although considering the recent and current disturbances on the global gas market it is rather challenging to provide long-term forecasts. It can be seen that the forecasted prices for natural gas are lower under the *Net Zero Emissions* and *Sustainable Development* scenarios, which are the scenarios designed to achieve net-zero CO_2 emissions by 2050 and to meet the objectives of the Paris Agreement on climate change and significantly reduce air pollution. In contrast, the *Announced Pledges* scenario highlights the "ambition gap" that needs to be covered to achieve the Paris Agreement goals, while the *Stated Policies* scenario provides a more conservative approach and does not take it for granted that all governments will reach all announced goals.

TABLE 10 – LONG-TERM NATURAL GAS PRICE FORECASTS

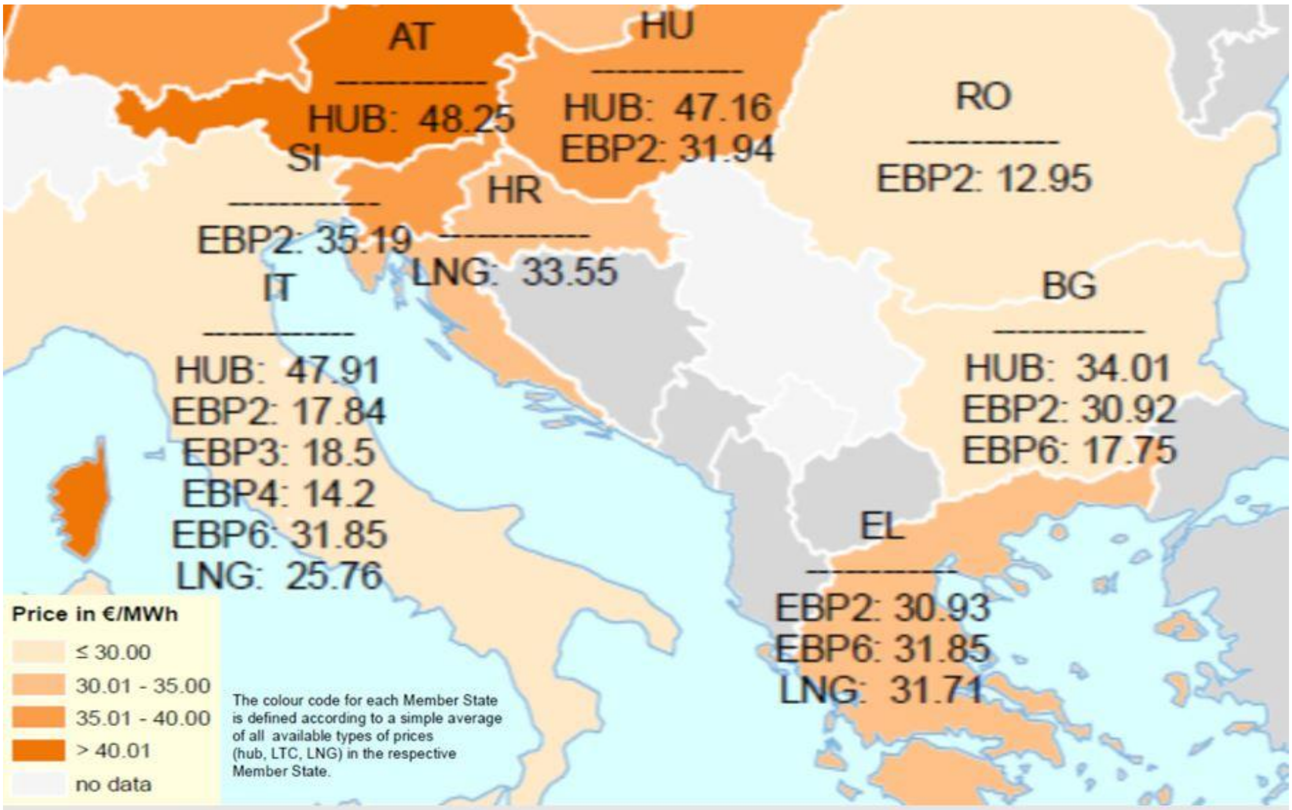
Natural gas			Net Zero Emissions by 2050		Sustainable Development		Announced Pledges		Stated Policies	
€/MWh	2010	2020	2030	2050	2030	2050	2030	2050	2030	2050
United States	15,6	6,0	5,7	6,0	5,7	6,0	9,3	6,0	10,8	12,9
European Union	26,4	12,6	11,7	10,8	12,6	13,5	19,5	19,5	23,1	24,9
China	23,7	18,9	15,9	14,1	18,9	18,9	25,5	24,3	25,8	26,7
Japan	39,0	23,7	13,2	12,6	16,2	15,9	22,8	20,4	25,5	26,7

Source: IEA World Energy Outlook 2021

On the regional level, according to the comparison of the wholesale gas prices provided in the Quarterly Report on European Gas Markets for the third quarter of 2021 (**Figure 29**), we can see that the gas prices in the region differ from country to country. However, this seems to be a consequence of the above-mentioned circumstances linked to the current disturbances in the global gas market. In normal circumstances, according to the historical data from the previous gas market reports, gas prices in the region are similar, and there are no dramatic differences in gas prices among neighbouring countries. Also, it can be noticed that the LNG prices are competitive compared to pipeline gas. As noted in the report, border prices are estimations of prices of piped gas imports paid at the border of the importing country, based on information collected by customs agencies, and are deemed to be representative of long-term gas contracts.

Considering the potential gas supply sources, currently, relevant gas prices for Kosovo would be prices in Bulgaria and Greece. In addition to the gas prices in Bulgaria, or Greece, as provided in **Figure 29**, the wholesale natural gas prices at the border of Kosovo would be increased for transmission costs through Bulgaria and North Macedonia, i.e. Greece and North Macedonia. In another scenario, if IAP and ALKOGAP would be developed and Kosovo would be supplied from Albania (via TAP and IAP) or Croatia (via IAP), the wholesale natural gas prices at the border of Kosovo would be the prices in Greece, and Croatia, increased for transmission costs through Albania.

FIGURE 29 – COMPARISON OF WHOLESALE NATURAL GAS PRICES IN THE THIRD QUARTER OF 2021



HUB *- prices at gas hub*
EBP *- estimated border prices at the border of the importing country*
EBP2 *prices are estimations of border prices for gas from Russia in period July to September 2021*
EBP3 *prices are estimations of border prices for gas from Algeria in period July to September 2021*
EBP4 *prices are estimations of border prices for gas from the Netherlands in period July to September 2021*
EBP6 *prices are estimations of border prices for gas from Azerbaijan in period July to September 2021*
LNG *prices for Italy and Greece are estimations based on customs data reported to ESTAT COMEXT for July to September 2021*

Source: Quarterly Report on European Gas Markets, Q3 of 2021, DG Energy, European Commission, 2022

The gas prices to be used for further analyses under this project are to be in line with the available long-term natural gas price forecasts.

Considering the climate goals set by the EU, the Consultant believes that the forecasts that best reflect the amounts of the gas prices for Europe are the ones provided in the IEA World Energy Outlook under the Net

Zero Emissions and Sustainable Development scenarios shown in **Table 10**; 11,7 €/MWh in 2030 and 10,8 €/MWh in 2050. Namely, these scenarios are designed to achieve net-zero CO_2 emissions by 2050 and to meet the objectives of the Paris Agreement on climate change and significantly reduce air pollution.

Although currently Kosovo does not employ any carbon pricing mechanism, the effect of carbon pricing will be considered. The prices will be in line with the available forecasts from relevant sources, such as ENTSO-G and ENTSO-E.

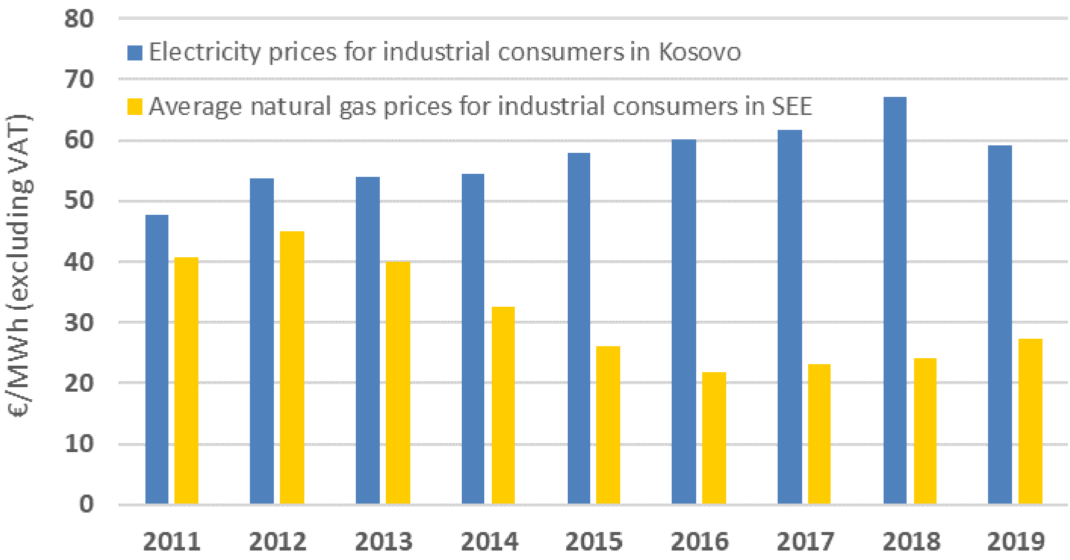
4.4 Gasification feasibility considerations

4.4.1 Gas competitiveness

Once natural gas is available to Kosovo consumers, the level of penetration of natural gas into the Kosovo energy market will depend on its attractiveness in comparison to alternative fuel options available. In the power generation sector, natural gas could provide diversification of baseload electricity generation as well as system balancing and reserve. It could also enable more flexible generation thus providing support to the deployment of renewable energy sources.

In the industry sector, natural gas is expected to be used primarily for technological and thermal purposes. It is expected that natural gas will primarily substitute oil products in technological processes and electricity for thermal purposes. Therefore, natural gas will be competitive fuel for the industry if its price is competitive to the price of oil products and electricity. The comparison[19] of the gas and electricity prices for industrial consumers in the SEE countries shows that the gas prices were on average 4,1 times lower than the electricity. Furthermore, since the electricity supply in Kosovo is insufficient and unreliable, natural gas could provide a secure and reliable energy supply for industrial consumers. **Figure 30** shows the evolution of electricity prices (excluding VAT) for industrial consumers in Kosovo in comparison to average natural gas prices for industrial consumers in SEE countries.

FIGURE 30 – HISTORIC ELECTRICITY PRICES FOR INDUSTRIAL CONSUMERS IN KOSOVO IN COMPARISON TO NATURAL GAS PRICES FOR INDUSTRIAL CONSUMERS IN SEE



Source: Energy Regulatory Office of Kosovo and European Commission Quarterly Reports on European Gas Markets

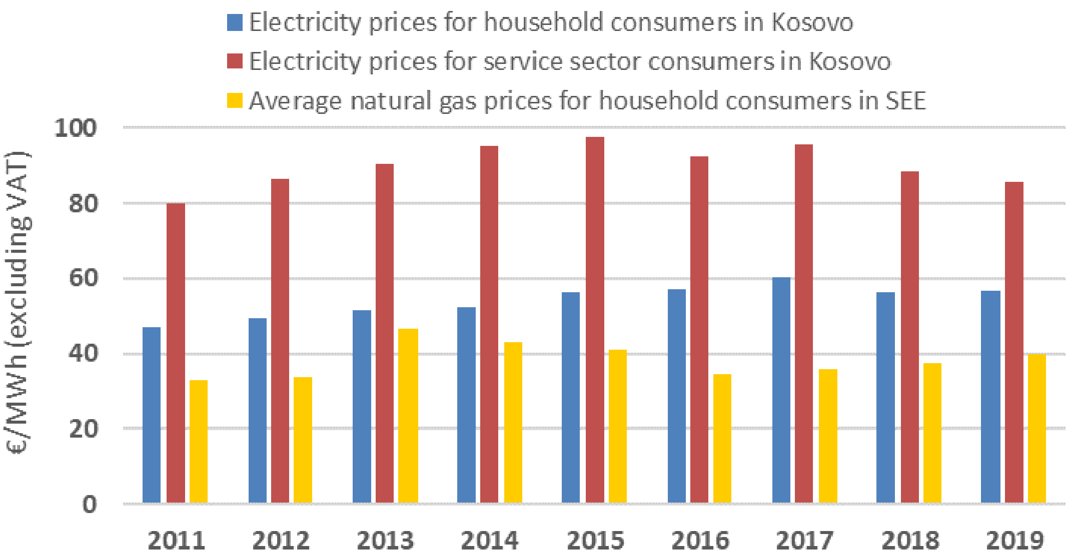
[19] *Quarterly Report on European Gas Markets, Q3 of 2021, DG Energy, European Commission, 2022*

In terms of the competitiveness of natural gas compared to other fuels, natural gas is shown as a competitive option, especially if consumers are forced to pay for carbon emissions. In such a case, natural gas is shown as the cheapest fuel option for industrial consumers.

For the services and household sector, natural gas is expected to be used for heating, cooking, and hot water preparation. In both sectors, it will substitute a certain part of the electricity consumption. Furthermore, it would substitute a certain share of the biomass (firewood) consumption in households, and a certain share of consumption of oil products in the service sector. To be competitive, final gas prices will have to be in line with the electricity prices. The comparison[19] of the gas and electricity prices for household consumers shows that the gas prices for households in the SEE countries were on average 3,2 times lower than the electricity prices.

Figure 31 shows the evolution of electricity prices (excluding VAT) for residential and commercial consumers in Kosovo in comparison to average natural gas prices for household consumers in SEE countries.

FIGURE 31 – HISTORIC ELECTRICITY PRICES FOR RESIDENTIAL AND COMMERCIAL CONSUMERS IN KOSOVO IN COMPARISON TO NATURAL GAS PRICES FOR HOUSEHOLD CONSUMERS IN SEE



Source: Energy Regulatory Office of Kosovo and European Commission Quarterly Reports on European Gas Markets

In the case of Kosovo, considering the efficiency (COP[20]) of the electric heat pumps, space heating with natural gas could be a more expensive option. However, heating with heat pumps in Kosovo could only be an option for well-insulated houses, which are rare in Kosovo. Therefore, there is an opportunity for the penetration of natural gas. On the other hand, the competitiveness of natural gas for heating low-energy houses is low due to the higher investment costs.

In comparison to biomass (firewood), natural gas is a more expensive option for space heating, but it brings a higher level of comfort (no need for preparation, storage, or kindling). Other than that, natural gas brings benefits such as stopping deforestation and air pollution and thus reducing health and environmental damage.

To resume, besides the comfort that heating with natural gas provides in comparison to heating with the fuel oil and firewood, the primary factor contributing to the competitiveness of gas is its final prices. The final price of natural gas consists of the energy costs (fuel costs, i.e., price of gas), network costs, and taxes. In 2021, the average share of energy costs in the total gas price paid by typical household consumers in the EU was about 50%. Network (transmission and distribution) costs were 25% on average, while the remaining 25% goes for energy taxes and VAT. While the fuel costs are determined by market forces, it is necessary that network costs

[20] *COP - Coefficient of Performance of heat pump is a ratio of useful heating power provided to electrical power consumed.*

(gas transmission and distribution tariffs) are competitive when compared to network costs in neighbouring countries.

4.4.2 Green deal considerations

Currently, it is generally accepted that hydrogen will be one of the main energy carriers in the conversion of the primary energy supply from renewable energy sources. Consumers in sectors such as transport, heating, and industry could in certain applications and to a certain degree adapt to pure hydrogen technology. Fossil natural gas, and methane from the re-methanisation of stored carbon monoxide/dioxide, and natural gas/hydrogen or methane/hydrogen mixtures are seen as a bridge technology for the following decades. Since pipelines are the most economic and ecological solution for the transport of large quantities of hydrogen, current investigations in the gas transport and storage sector are aimed at converting and reusing existing pipeline networks as well as at optimising modern steel materials for new installations. The focus is on hydrogen/gas mixtures and, of course, pure hydrogen (100% H_2).

In December 2019, the European Commission presented the European Green Deal, an ambitious package of measures that should ensure that the EU meets its climate goals while enabling it to benefit from a sustainable green transition. In this transition, the gas transportation system would need to develop in a way that is consistent with the decarbonisation and climate neutrality objectives of the Energy Union.

European Green Deal's goal is to decarbonize European economies by 2050. Nevertheless, exceptions with regards to timing of decarbonization are allowed in particular cases. For the purposes of this assignment, the Consultant has assumed Kosovo will need to decarbonize its economy by 2060.

Decarbonization will involve the replacement of fossil fuels with alternative energy sources, most notably electricity. In terms of gas, the European Green Deal stipulates some principles on how gas markets should be developed in the energy transition. It determines how the power sector must be developed that is based largely on renewable sources, complemented by the rapid phasing out of coal and decarbonizing gas. The decarbonisation of the gas sector should be facilitated via enhancing support for the development of decarbonised gases, via a forward-looking design for a competitive decarbonised gas market and addressing the issue of energy-related methane emissions. Security of supply is still among the key principles when it comes to the development of European Gas markets in light of decarbonization. Security of supply, being a concept under Article 194 of the Treaty on the Functioning of the European Union, can be a trigger for the state aid for the development of infrastructure in the Member States with less diversified gas markets. This means the opportunity for East and Southeast Europe countries to decarbonize their systems by adopting combined cycle power plant technology instead of high polluting coal for which development of gas networks is a prerequisite, or to develop high-efficiency cogeneration instead of coal, which is already enabled under the Energy Efficiency Directive.

To sum up, the European Green Deal does not stipulate the exact role of European Gas Networks within the Energy transition, but the broader umbrella of European Law on the path toward the Energy Union determines the decarbonization of gas networks and even foresees the use of the decarbonized gasses like green hydrogen.

In order to meet the EU's climate and energy targets and reach the objectives of the European Green Deal, a clear definition of what is 'sustainable' is needed. This is why the action plan on financing sustainable growth called for the creation of the "EU taxonomy". The EU taxonomy is a common classification system that establishes a list of environmentally sustainable economic activities. It should play an important role in helping the EU scale up sustainable investment and implement the European Green Deal.

In April 2021, the European Commission published the rules establishing which economic activities could be defined as green under the taxonomy, but it delayed deciding whether to include natural gas and nuclear power. In February 2022, the Commission presented a Taxonomy Complementary Climate Delegated Act on climate change mitigation and adaptation covering certain gas and nuclear activities. This document sets out clear and strict conditions, under Article 10(2) of the Taxonomy Regulation, subject to which certain nuclear and gas activities can be added as transitional activities to those already covered by the first Delegated Act on climate mitigation and adaptation, applicable since 1 January 2022. These stringent conditions are: for both gas and nuclear, that they contribute to the transition to climate neutrality; for nuclear, that it fulfils nuclear and environmental safety requirements; and for gas, that it contributes to the transition from coal to renewables. As per natural gas, gas-related activities covered with the Taxonomy Complementary Climate Delegated Act cover (i) electricity generation from fossil gaseous fuels, (ii) high-efficiency co-generation of heat/cool and power from fossil gaseous fuels, and (iii) production of heat/cool from fossil gaseous fuels in an efficient district heating and cooling system.

Each gas-related activity needs to meet either of the following emission thresholds:

lifecycle emissions are below 100g CO_2e/kWh, or

until 2030 (date of approval of construction permit), and where renewables are not available at a sufficient scale, direct emissions are below 270g CO_2e/kWh or, for the activity of electricity generation, their annual direct GHG emissions must not exceed an average of 550kg CO_2e/kW of the facility's capacity over 20 years. In this case, the activity must meet a set of cumulative conditions: e.g., it replaces a facility using solid or liquid fossil fuels, the activity ensures a full switch to renewable or low-carbon gases by 2035, and regular independent verification of compliance with the criteria is carried out.

In the case of Kosovo, natural gas is seen as a transition fuel from its current dependency on coal. On the other hand, the decarbonization goal by 2060 leaves a relatively short time for adequate recouping of the investments in natural gas infrastructure, but also for recouping investments in the equipment of potential natural gas users.

One way in which the existing gas networks could contribute to this energy transition is via adaptation or repurposing of existing infrastructure so that they could handle admixtures of hydrogen and natural gas or pure hydrogen injections. According to the ToR of this assignment, all pipelines should be built to be capable to transport 100% of hydrogen.

A significant portion of H_2 will likely be used outside of the natural gas network. The role of H_2 is expected to be twofold:

Energy storage in electricity systems; hydrogen being produced at times of excess renewable electricity generation and stored for re-conversion to electricity at times of insufficient renewable electricity generation. Thus, hydrogen would facilitate balancing of renewables electricity generation. Hydrogen generated from excess renewable electricity is expected to be produced locally in Kosovo and potentially imported from neighbouring countries. Locally produced hydrogen may not use the natural gas interconnections, and only partially use the natural gas network.

For specific applications where substitution of fossil fuels with electricity wouldn't be feasible; in specific industry processes and for freight transport. Industrial use may use the natural gas transmission network or dedicated H_2 networks, while freight transport is expected to use LNG supplied from regional LNG terminals.

As explained later in Chapter **6.2** current technology and infrastructure isn't suitable for hydrogen content in gas higher than cca 20%. Hydrogen-natural gas blends with higher percentage of hydrogen are possible, but require specific adjustments to infrastructure and facilities. High variations in blend composition are generally not tolerated well. This issue will become more relevant as hydrogen content will increase, however the technology improvements are expected as well.

4.4.2.1 100% H_2 dedicated networks

Industrial 100% H_2-dedicated pipeline networks are in operation in Belgium, France, Germany, and the Netherlands, i.e., networks that connect several industrial sites. These H_2 pipeline networks are not operated by a TSO or a DSO and are generally used to supply hydrogen to refineries, fertilizer plants, and other industries [4].

In Belgium, there is a highly developed H_2 pipeline network of more than 600 km, with cross border connections to the Netherlands as well as to France. The H_2 pipeline network serves to supply H_2 for industrial processes (e.g. oil refineries) and is operated by H_2 production companies (e.g. Air Liquide). The network operates at a pressure between 10 and 20 bar. Thus, available experience with 100% hydrogen pipelines is limited to both lower capacity and lower pressures than expected in transmission pipelines.

In 19 EU countries, there are currently no plans for developing 100% H_2 pipelines or networks. Only Germany, France, Poland, and the Netherlands are planning to develop 100% H_2 pipelines/networks, but it is not yet determined who will promote these projects (the TSO or non-TSOs parties). In Germany, it is not yet decided whether 100% H_2 new dedicated pipeline networks will be operated by a regulated TSO. The decision is subject to an ongoing political process [4] .

Several EU countries such as Austria, Belgium, Germany, Latvia, Portugal, Spain, France, Romania, Poland, the Netherlands, and Sweden have recently developed national H_2 strategies. France, Germany, and the Netherlands have published a dedicated H_2 strategy or vision, while several other National Regulatory Authorities (NRAs) report ongoing discussions regarding the role of H_2, in particular in the context of the national energy and climate plans (NECPs), but also recovery plans in the aftermath of the COVID-19 pandemic and the more ambitious decarbonisation targets currently being discussed [4].

5 INSTITUTIONAL, LEGISLATIVE AND POLITICAL FRAMEWORK

5.1 Institutional aspects

An appropriate and effective institutional framework is crucial for the successful introduction of natural gas in Kosovo territory. It implies appropriate coordination between Kosovo institutions responsible for the creation of energy policy and its implementation, regulation of the energy sector as well as corresponding international cooperation.

It is assumed that the Republic of Kosovo intends to keep the key strategic role as an energy policymaker, owner of a strategic share in gas infrastructure, and creator of the legal and regulatory framework of the gas sector.

The current institutional framework of the energy sector originates in the position of Kosovo as a member of the Energy Community and constitutional order of the country.

Therefore, with recourse to the hierarchy of law according to which ratified international agreements are above the national laws, the energy sector holds an important place in the Stabilization and Association Agreement (SAA) entered into force in 2016. Under the SAA (Article 114), Kosovo is obliged to fulfil obligations related to the integration of the regional common market, which includes the Energy Community Contracting Parties. Moreover, Energy Community Treaty (ECT) lays the foundations for the institutional and organizational design of the energy sector in Kosovo as a member of the Energy Community and thus determines the national strategic goals for the energy sector: 1) leading role of the state to create a single regulatory space for trade in energy, 2) to develop energy market competition on a broader scale to provide all citizens with energy based on a public service obligation, 3) possibility to organize the ownership of energy infrastructure in a manner to own strategic facilities and key energy undertakings.

In the context of broad competencies of state institutions, the responsibility for various aspects of the energy sector is split amongst several different public institutions/agencies with a direct and indirect impact on the development of the gas sector. Their competencies are determined in general by constitutional provisions, state administration regulation, and laws governing special administrative areas such as energy, spatial planning, construction, environmental protection, etc.

Law on Energy from 2016 is adopted as the principal domestic piece of legislation in the determination of a regulatory framework for the development of policies and strategies, and the role of stakeholders in their implementation, to ensure sustainable and efficient energy supply. Law on Energy determines the Ministry of Economy as the principal competent state body for the energy sector. The legal status, rights and obligations of participants in the gas sector are prescribed by Law on Natural Gas.

The legislative power is exercised by the Assembly of the Republic of Kosovo. As such, the Assembly is the highest representative and legislative institution in the Republic of Kosovo responsible, inter alia, for the adoption of laws and resolutions in the areas of responsibility of interim institutions and reviews and ratifies the proposed international agreements, within the scope of its responsibilities. Related to the aspect of energy policy creation, the Assembly adopts Energy Strategy upon approval by the Government. The Assembly also appoints the members of the ERO's Board and supervises ERO's work by accepting the ERO's annual reports.

The President of the Republic of Kosovo is the head of the state and represents the unity of the people of the Republic of Kosovo. President among other competencies defined by Constitution. President among other competencies represents the Republic of Kosovo internally and externally and promulgates the law adopted by Assembly.

The Government of the Republic of Kosovo exercises executive power in accordance with the Constitution and with law. The Government implements the laws and acts ratified by the Assembly of Kosovo and carries out other activities within the responsibilities defined by the Constitution and law. Regarding the energy sector, the Government reviews and approves the Energy Strategy before being sent to the Assembly for adoption. In addition, Government adopts a Strategy Implementation Program, a three-year operational document for the implementation of energy policy. Concerning the ownership and development of gas the gas infrastructure, the Government shall, during the selection procedure, appoint operators of transmission and distribution systems and thus control the operation and development of the gas network.

Following the institutional competence in Kosovo, the Ministry of Economy is currently in charge of energy affairs. Within the Ministry, a special Department of Energy has been established with the main tasks and responsibilities for the proposition and implementation of energy sector policy/strategic document and legislation and implementation of tasks deriving from the Energy Community Treaty. The Department of Energy comprises of Energy Systems Division, Renewable Energy Sources, Efficiency and Cogeneration Division, Energy Policies Division, and finally Technical Standards and Regulations Division. Ministry of Economy develops Energy Strategy (ten-year period) which includes development goals to transform the energy sector into a sustainable and financially viable sector, as well as to identify key energy policies to be undertaken to attract private investments, protect the environment and integrate Kosovo's energy sector into regional and European systems. Ministry also prepares position papers and guidelines and the abovementioned Energy Strategy Implementation Program. Operationally, Ministry prescribes and supervises all the administrative proceedings concerning authorization, certification, and licensing procedures applied to network participants, and issues sub-legal acts set forth by the energy laws.

Energy Inspectorate under the auspices of the Ministry of Economy conducts administrative oversight of the implementation of laws related to the energy sector and all other subsidiary legislation implementing these laws.

The Energy Regulatory Office (ERO) was established in June 2004 as the national regulatory authority, under Law on Energy Regulator as the principal legislation establishing competencies, authorities, and functions thereto. ERO is managed by 5 members Board which is appointed by the Assembly of Kosovo. The headquarter is in Prishtina. ERO is a member of the Energy Community Regulatory Board (ECRB) and Council of European Energy Regulators (CEER), among other cooperation. ERO is an autonomous, functionally independent entity that is funded with fees collected in the authorization and licensing of energy activities. It issues, modifies, and revokes licenses for performing natural gas activities and keeps the registers of issued, modified, and revoked licenses. The important responsibility is the TSO's certification in accordance with legal requirements concerning the unbundling and decision-making independence criteria. ERO has the competencies to set in prior the principles and methods of determining the gas tariffs and later approve the tariffs for the regulated gas market activities. This function also includes tariff monitoring, dispute resolution, service quality, and standards for performing gas market activities. ERO shall have the key role of approval of secondary legislation for the gas market which includes tariff methodologies for access to the gas system, transmission and distribution network rules, rules for capacity allocation, balancing rules, etc. Although being independent of state authorities and gas undertakings as well, cooperation with the Ministry of Economy in policy implementation is the key to efficient infrastructure development that should ultimately result in a functional gas market.

Energy Community Secretariat (ECS) participates as a supervisory body in the activities of the ERO and has a right to review the information and documentation related to the licensing of public service obligations. It may request certification to ensure compliance of the network operators and participates in certification concerning third countries. In addition to the above, it performs the function of monitoring reports in the field of security of supply.

Local government bodies shall plan in their development documents to consider the need and the manner of energy supply and shall harmonize those documents with the Strategy Implementation Program, and energy balances. Furthermore, local government bodies shall also cooperate with market participants and state bodies on issues of the right of access to lands for the placement of energy equipment and energy facilities.

Other ministries and state agencies also participate in the organization and development of the natural gas market, especially within the Ministry of Environment and Spatial Planning and Infrastructure (MESPI). Thus, in network construction, the Construction Department of the MESPI issues permits and supervises construction. The issuance of environmental permits and special permits for the use of public goods is the responsibility of the Environmental Department, Spatial Planning Department, or Water Department.

The administration of environmental protection is divided between Government, MESPI, and municipalities. To monitor the environmental qualities and attributes, MESPI established the Kosovo Environmental Protection Agency (KEPA).

The development of gas infrastructure through the implementation of Public-Private Partnership (PPP) models should be organized in coordination with the Ministry of Finance and its Central Department for PPP, under the Law on Public-Private Partnership.

In addition to the Energy Regulatory Office, other state agencies should be identified as part of Kosovo's legal framework. Their establishment and independent operation are based on Article 142 of Constitution of the Kosovo which regulates independent agencies as institutions established by the Assembly based on the respective laws that regulate their establishment, operation, and competencies. Independent agencies exercise their functions, independently from any other body or authority in the Republic of Kosovo. The independent agencies have their budget that shall be administered independently under the law.

Kosovo has not yet established an institution to oversee upstream hydrocarbons in exploration and development and organize them competitively, as does the role model of the Hydrocarbons Directive 94/22/EC of the EU. The legal basis for hydrocarbons management could be found in Article 122 of the Constitution of Kosovo, and the legislator has yet to establish a special agency. Another possible solution should be an expansion of the competence of the Independent Commission for Mines and Minerals (ICMM). ICMM regulates mining activities in Kosovo in accordance with applicable law, the sub-normative acts issued according to the Law on Mines and Minerals, and the Mining Strategy.

Considering the role of consumers in the internal energy market an important role in protecting and empowering the consumers is given to competition agencies. In Kosovo, this role is given to Kosovo Competition Commission (KCC) as an independent body with responsibility for promoting competition among undertakers and protecting customers in Kosovo.

The authority responsible for enforcing the Law on State Aid consists of a State Aid Department (SAD), within the Ministry of Finance which receives, analyses, and monitors notifications, and a State Aid Commission (SAC), the decision-making body.

Kosovo's Business Registration Agency (KBRA) operates within the Ministry of Trade and Industry. KBRA carries out the registration of all business organizations and foreign business organizations under the Law on Business Organization.

Kosovo Investment and Enterprise Support Agency (KIESA) is a state agency with a mandate to promote and support investments, including those related to the energy sector.

The annual Energy Balance for the previous year is prepared, approved, and published by the Kosovo Agency of Statistics (KAS). From January 2022, KAS has started to release the Energy statistics monthly.

There are currently no gas transmission and distribution system operators in Kosovo. According to the Law on Natural Gas, the Government of Kosovo shall select and designate, based on a competitive process, legal persons as candidates for transmission and storage system operators. Since Kosovo has implemented the Third Energy Package, the entity carrying out the duties of a system operator must be independent of generation and supply activities in natural gas, and related commercial interests. This can be done through the full ownership unbundling because the Law on Natural Gas in so far does not recognize ISO or ITO models, which is possible under the Gas Directive. Concerning the independence of the operator, the independence of the staff and management of operation of the TSO shall be granted by the Supervisory Body which ex-ante confirms compliance with regulatory requirements. The Board of Directors is the body that will operate the TSO, and in case the entity is established as a public enterprise, the members of the Board of Directors must be subject to the Law on Publicly Owned Enterprises in their election and mandate. Although the law does not specify the legal form in which a TSO will be established once, it has left the possibility to do so through public-private models while guaranteeing ownership, and functional and operational separation from other market participants, presumably to successfully attract the capital needed for investment. In this part, the ERO will play a key role in the operator certification process. In the network development process, the TSO will continue to work with the ERO through 10-year development plans assessed on supply and demand forecasts, after having consulted with all relevant stakeholders. The Ministry of Economy, in line with the legislation in force, will assess the need to expand the existing gas network infrastructure, to enable the integration of gas from renewable energy sources. In case the TSO will not have the capacity or will not make the necessary investments, the ERO has a corrective function as a second instance supervisor. All the above for the transmission system operator applies to both distribution system operator(s) and gas storage operators.

In Kosovo currently, there are not any enterprises in the natural gas sector, due to the undeveloped market. This includes enterprises upstream, traders, suppliers, and others. Speaking of the system enterprises, a broader definition would encompass distribution (establishment of local distribution companies) and transmission system operators, LNG facilities, and gas storage operators, for which the owner is not limited to the state.

Therefore, even though there is no gas in Kosovo, the energy laws, especially the Law on Natural Gas have defined the tasks and responsibilities of state institutions, and the gas system operators have yet to be established and organized following legal provisions.

Further development of institutional frameworks implies strengthening institutional capacities (Ministry of Economy, ERO, and TSO/DSOs) concerning operation of gas system, through additional training and education within the technical assistance program.

5.2 Legislative aspects

Legal aspects that have an impact on the introduction of gas into Kosovo's territory of Kosovo are determined by laws of several legal fieldsetc.).

Although Kosovo's Constitution does not contain specific provisions on energy, keeping in mind the hierarchy of legal sources, it is necessary to consider Constitutional provisions relating to general principles for conducting economic activity, disposal of natural resources, organization, and responsibilities of State and local government and role of independent agencies in the considering of legal aspects of Kosovo's gas sector development.

As stated earlier an integral part of Kosovo's legal system is the ratified international agreements, Energy Community Treaty (ECT, 2006), and the Stabilization and Association Agreement (SAA, 2016). ECT and SAA impose the harmonization of the national legal framework with Acquis for Energy and gradually integration of Kosovo into Europe's energy markets.

Despite the lack of gas infrastructure and gas undertakings, following ECT's obligations, Kosovo was supposed to transpose the Gas Acquis (Gas Directive 2009/73/EU and Gas Regulation 715/2009/EU), Security Supply Directive 2004/67/EU as well as the Competition Acquis (Articles 81, 82, and 87 of Annex III of the ECT). It is done by an energy legislative package from 2016, Law on Energy, Law on Energy Regulator, and Law on Natural Gas as lex specialis for the gas sector. These laws define the main principles of function of the energy sector and give ERO the power to regulate and control the gas market. The laws transpose the formal requirements of respective directives and regulation and set foundations for planning and development of the gas sector, carrying out gas activities, operation of the natural gas system and market, and supply of final customers with natural gas including protection of socially vulnerable categories.

ERO followed the normative activities related to the gas sector through the adoption of its regulations including the Licensing rules, the TSO's Certification rules, and REMIT.

For the completion of the legal and regulatory framework for natural gas, it shall be necessary to draft and adopt envisaged secondary legation as defined by Law on Energy Regulator and Law on Natural Gas, firstly for the gas system operation and secondly for gas market function. This involves the adoption of specific rules such as gas network rules (transmission/distribution network rules, capacity allocation rules, congestion management rules, balancing rules), gas market rules, switching rules, general conditions for gas supply, service quality rules, etc. (please see Annex 1 of *Institutional and Market Review Report, March 2022*). Development of these regulations shall require specialized expertise and the strengthening of the administrative capacity of responsible institutions and gas enterprises.

The development of gas infrastructure shall be organized under the provisions of the Law on Natural gas and Law on PPP that applies to all energy infrastructure (except the new electricity generation capacity) including the gas pipelines. Law on PPP establishes the legal framework for Public-Private Partnerships, including the contract awarding procedure, the content and structure of PPP contracts, and the institutional framework responsible for the management and development of PPPs in Kosovo. Concerning gas infrastructure projects, the PPP refers to forms of cooperation between public authorities and the private sector which aim to ensure the financing, construction, management, operation, and/or maintenance of gas infrastructure and/or the provision of a service gas transmission and distribution.

The construction of gas pipelines must be planned and carried out under the regulations on spatial planning and construction as well as on environmental and nature protection (Law on Spatial Planning, Law on Construction, Law on Environmental Protection, Law on Nature Protection, Law on Environmental Impact Assessment, etc.). It implies the incorporation of the gas infrastructure in the relevant spatial planning documents, the public participation in the authorization procedures, compliance with safety and technical conditions and regulations, and the implementation of measures to avoid or mitigate negative environmental impacts.

The development of gas infrastructure also requests the settlement of property rights on land through land expropriation, land purchase, the acquisition of concession, or the long-term lease providing for commercial exploitation of property. Therefore, at the earliest stage of each project, investors will need to cooperate with the state to select an appropriate model for acquiring rights over properties covered by the gasification project and allocate sufficient funds in time to acquire them. It is important to note that the Constitution of Kosovo guarantees property rights and does not differentiate between foreign and domestic investors. Above mentioned models of regulation of property rights have a legal ground in the provision of the Constitution, Law on Property and other Real Rights, Law on Establishing the Immovable Property Rights Register, Law on Public-Private Partnership, Law on Natural Gas, and Law on Expropriation of Immovable Property.

The legal framework for the establishment of new gas enterprises in Kosovo consists of the Law on Business Organizations and Law on Publicly Owned Enterprises. Kosovo provides for registered business organizations, established for permitted purposes, and registered with the Registry, with mandatory public access to the records. As for the type of companies suitable for gas undertakings, the Law on Business Organizations offers a Limited Liability Company and a Joint Stock Company. The exercise of ownership rights in publicly owned undertakings that carry out infrastructure activities in the general interest and their corporate governance is regulated by the Law on Publicly Owned Enterprises according to which publicly owned enterprises (carrying out the economic activity in general interest and owned by the state) are established as Joint Stock Companies and operate under the Law on Business Organization.

The Law on Business Organizations grants for the registration of foreign business organizations or for foreign capital to establish a company thereto. In that sense, it is important to point out that Kosovo under the Law on Foreign Investment guarantees fair and equal treatment to all foreign investors by international standards. The Law on Strategic Investments regulates the procedures for the attraction and selection of foreign investments categorized as strategic investment/project, local or foreign, with the purpose to improve and facilitate a business environment and investment climate.

Finally, current Kosovo's legal framework provides sufficient legal ground for further regulatory and institutional development of the gas sector. The future progress in the legal and regulatory framework, meaning the adoption of envisaged secondary legislation in line with the Gas Directive and Gas Regulation (tariffs, network rules, market rules, conditions for gas supply, switching rules, etc.), will require the establishment of functional system operators and building and commissioning a gas infrastructure.

5.3 Political aspects

The development of institutions and gas network infrastructure to complete the gas market in Kosovo depends on a strong political commitment of the Government, for which the foundations were laid back in 2017 with the adoption of the Energy Strategy of the Republic of Kosovo 2017-2026. In addition to the goals related to green transition instruments such as the introduction of renewable sources, sustainable development, and energy efficiency, the Energy Strategy itself sets out a specific objective for the construction of gas infrastructure. Building gas infrastructure as a goal, together with the principles of security of energy supply and integration into regional energy markets within the Energy Community, create a clear commitment of Kosovo towards natural gas and an obligation to implement the next steps to achieve this. In addition to its political strategies, Kosovo is also obliged by the international treaties it has ratified.

In parallel to Kosovo's efforts under the Energy Community umbrella which mostly relate to liberalized energy markets, another dimension in terms of energy policies is sustainable development concerning tackling climate change. At the moment, as per Kosovo's commitments under international law, the obligations regarding climate policies arise from the Governance Regulation 2018/1999, being part of EnC acquis, which sets common rules for planning, reporting, and monitoring energy and climate policies and targets. In particular, the Contracting Parties will be required to submit National Energy and Climate Plans. Moreover, though Kosovo did not ratify the United Nations Framework Convention on Climate Change of 1992, the Kyoto Protocol of 1997, and the Paris Agreement of 2015, it should consider adopting policies that mirror the carbon goals of those agreements. In doing so, the county would enable possibilities for the adoption of cross-border climate policies and facilitate its path towards a sustainable economy.

Furthermore, though not being a Member State of the European Union, Kosovo through Western Balkan Green Agenda should keep the track of the policies developed under the European Green Deal, which sets the long-term direction of travel for meeting the 2050 climate neutrality objective through all policies, in a socially fair and cost-efficient manner and ensures that the transition to climate neutrality is irreversible. The European Green Deal and EU Green Agenda for Western Balkan do not exclude natural gas from their roadmap but rather underline that gas infrastructure should be compatible with decarbonized gases in the future. Subsequently, the role of natural gas as a transitional fuel is recognized under the 2014 Alternative Fuels Infrastructure Directive foreseeing the LNG as a key transitional fuel to the green economy. Nevertheless, the construction of a gas system and establishing a properly liberalized gas market must be the first strategic steps for Kosovo in joining EU energy markets.

The obligation to create and integrate energy markets resulted in the adoption of three pieces of law that laid the basis for market construction and further implementation of the gas sector development policy, namely the Law on Energy, Law on Energy Regulator and Law on Natural Gas. With these activities, Kosovo has sufficiently aligned its legislation with the acquis communitaire of Energy Community, so further development of the legal framework, notably secondary law covering network codes and market rules will depend on the network construction. Given that the previous condition for network construction is the establishment of a gas system operators, Kosovo's efforts should be focused on building institutions and the establishment of a capable transmission system operator. In accordance with the Law on Natural Gas, the designation of a TSO should be made through a form of public-private partnership, but it is necessary to prior establish an adequate company to be a vehicle for those activities.

Therefore, the key policy action of the Kosovo Government in building the gas market should be the decision to set up a company to be appointed as the transmission system operator. This company must be strategically designed, preferably in the state ownership, should have a capital structure that would allow financing the construction of the network either through the capital of foreign partners, the possibility of access to capital markets or institutional loans. The establishment of a gas TSO is a prerequisite for network development because only the gas TSO plans the development of the gas network and through cooperation with the neighbouring TSOs ensures the integration of the national gas system into regional markets. The gas network development plans and interconnections both are subject to prior regulatory approval and are also the basis for project financing of network construction. The once-established transmission system operator should then engage in various forms of international cooperation with all stakeholders in the gas sector, both institutional and gas business, in order to strengthen its capacity for the operational phase once the network is built.

Moreover, the foundation of the gas transmission system operator should be the strategic goal of Kosovo's energy and gas policy. The roadmap itself to complete the gas market while respecting the obligations under the Energy Strategy in terms of sustainability includes the following activities:

1. Continuation of policy activities towards climate neutrality and integration into the Internal Energy Market of the EU and EnC;

2. Necessity to change/amend laws related to the establishment of gas TSO - adopt standards for the protection of foreign investments and amendment of the laws to allow the future TSO to own the gas network (property rights). In addition, as underlined in the Institutional and Market Review Report, to revise ERO's Rules on certification for transmission system operators;

3. Establishment of a gas transmission system operator company;

4. Design and certification of the gas TSO, and certification of the gas TSO in relation to the third countries;

5. Strengthening of the capacities of gas TSO, Ministry of Economy and Energy Regulatory Office, allocation of sufficient funds for their empowerment, and creation of the natural gas market in cooperation with foreign institutions, gas undertakings, and gas market actors. In addition, it is necessary to carry out tailor-made marketing campaigns to educate citizens on their role as future customers;

6. Considering the other legal aspects supplementing the development of gas infrastructure, including designing contractual transport and supply arrangements, secondary law preparation, legal management for expropriations, etc.

In conclusion, the adoption of the aforementioned roadmap would ensure that the Kosovo is making credible and measurable progress toward the widespread introduction of natural gas in country, and towards its obligation stemming from the membership in the Energy Community.

5.4 TSO/DSO market models

As previously stated, the establishment of gas system operators should be the strategic goal of Kosovo's energy and gas policy to ensure the country's gasification and developing a natural gas market. This must be done following the Law on Natural Gas which directly refers to the Law on Energy Regulator and Law on Public-Private Partnership. Law on Energy Regulator determines the procedural framework for certification of system operators, while Law on Private-Public Partnerships provides the rules on award of rights to construct and/or operate the gas network infrastructure.

It is important to emphasize that in accordance with Law on Natural Gas the Government of Kosovo shall select a company for gas TSO service in a public tendering process conducted by Law on PPP. A selected company must later be licensed and certified by the ERO following ERO's rules. When the ERO confirms a selected company complies with rules on ownership unbundling, the Government of Kosovo shall finally approve and designate a gas TSO, respecting the official opinion of the Energy Community.

As the entering the procedure of TSOs establishing is a political decision, such commitment of the Government can be done in parallel to broader legislative activity that would improve other applicable legislation concerned with the development of a gas market in Kosovo. These legal issues include property rights, foreign investment protection, corporate governance, etc.

What differentiates Kosovo from other EnC members is a lack of any gas activities and gas undertakings or more specifically any vertically integrated gas company, thus in Kosovo, there is no need to unbundle an existing gas company. That is the reason why the Kosovo legislator through the Law on Natural Gas accepted a single market model for gas TSO, full ownership unbundling of a transmission system operator. Hence, the Law on Natural Gas determines for gas TSO to be fully unbundled in ownership from gas production and supply functions. Compliance with ownership unbundling means that the undertaking which is the owner of the transmission system also acts as the gas TSO and is consequently responsible for building the gas network, granting and managing third-party access on a non-discriminatory basis to system users, collecting access charges, congestion charges, and payments under the inter-TSO compensation mechanism, and maintaining and developing the gas network trough. As regards investments, the owner of the transmission system is responsible for ensuring the long-term ability of the gas transmission system to meet reasonable demand through investment planning. The Law on Natural Gas itself does not set any limitations in terms of ownership or capital for the companies concerned.

As for DSO, the legal requirements are less strict. This is due to the fact of the role of public services that distribution networks might serve. So, the Law on Natural Gas for DSO requires only separation in form of a legal form, organization, and decisions, from other activities not related to gas distribution. The same applies to gas storage system operators.

Concerning the DSO selection procedure, Government of the Kosovo shall select and designate, based on a competitive process one or more legal persons as candidates for DSOs, and candidates shall apply for a license to ERO. Furthermore, the development of the gas distribution network and the determination of the DSO should take place through the application of the Law on Public-Private Partnership and PPP models such as concession.

The Law on Natural Gas with Art. 31. introduces the possibility of a gas Combined Operator as an undertaking that comprises of transmission, storage, and distribution system operator if the combined operator complies with requirements for the unbundling and independence of the TSO. This possibility needs to be developed in cooperation with the responsible state institutions (Ministry, ERO) and through further strengthening of the institutional capacity of the system operator and supporting the development of tariff methodologies and network codes.

The Law gives possibilities to select and establish one or more gas TSO and DSO(s). The Consultant notes that these options should be considered taking into account the state's goals of gasification of the country, namely in the function of i) encouraging economic development, ii) diversification of energy sources iii) cost optimizations of network maintenance, iv) ensuring of natural gas security and affordability for consumers and v) energy transition with decarbonization. Additionally, other parameters such as network distance, technical characteristics, number of consumers, etc. should be considered.

In this context, a single gas TSO is suggested (one of the options is that it is KOSTT, electricity TSO, respecting unbundling requirements across the electric and gas sector) which shall manage the development and construction of gas transmission infrastructure through an adequate investment plan and access to financial sources.

At this moment, no specific gas undertakings are recognized as potential candidates for the role of the gas DSO(s) which would develop natural gas distribution network(s) in Kosovo.

The development of Kosovo's gas distribution system will take place through the application of the PPP model, work and service concession, where the public authority (Government of Kosovo), through defining the criteria of the concession may choose option i) in which one national DSO will develop a gas distribution network through the country or ii) where the gas distribution sector will be fragmented into several concession areas operated by different concessionaires-DSOs.

In both cases, the selected candidates for DSOs must meet the set regulatory requirements and the criteria of technical and financial capacity. Also, in both cases, a concession for a certain area can be obtained by only one entity, so it is a kind of natural monopoly and should be regulated by the state through legal vehicles a concession and a regulatory license.

Also, the current legal framework (Law on Natural Gas and Law on PPP) as a public authority recognizes the central government, but, in most of the EU countries, distribution was developed by or together with local or regional authorities, mostly in the form of local distribution monopolies.

Therefore, it is possible to consider an option to include local government (municipalities) in the tender procedure, through amendments to the legal framework, or through the establishment of contractual cooperation keeping in mind their development needs and allocation of funds (concession fees and other taxes) into local budgets.

The establishment of a single DSO at the state level would mean its better negotiationg position towards suppliers including lower investment costs, (construction costs, procurement of equipment and metering devices, uniform technical standards, single contracting, etc.). thus, contributing to faster gas distribution network construction, lower tariffs, better service quality, and business stability.

Also, given the size of the concession area, the length of the network, and the network user's number, this option would probably attract a reputable „large"company that would have all the necessary technical, financial and human capacity to implement the project.

However, a single DSO as a monopolist for the whole country can pose a threat to competition and it is important that the state through a transparent and stable regulatory framework, on the one hand, gives the incentive to build a network and guarantee the security of return of investment, and on the other hand guarantees affordable and secure access to the gas distribution network.

The second option would include more "smaller" distributors in several different distribution areas, related to the city or several municipalities. This option may result in more qualified candidates with the ability to i) raise the capital needed for initial distribution system investment and future expansion, ii) identify the specific needs of the local government and strength local business infrastructure and create local jobs. The main disadvantage is the potentially higher costs of network construction and distribution services during the concession period and complex requirements for state administration.

6 TECHNO-ECONOMIC ASSESSMENT OF THE TRANSMISSION SYSTEM

6.1 Basic information

As a part of the initial development of a gas development plan, a provisional gas transmission network throughout Kosovo is developed with the goal to reach all major consumption centres in a most economical way and with minimal impact on the environment. The proposed concept relies on the connection to the North Macedonian gas transmission system.

Official national topographic maps 1:25000 were used along with publicly available Google Earth map software to lay the pipeline routes. Suitable corridors/routes are selected for pipelines, minimizing the length, cost, and environmental impacts of the proposed pipeline system. Basic hydraulic optimisation has been carried out.

In general, the provisional pipeline routes will be assessed from technical, economic and environmental standpoint and their feasibility for construction established. Pipelines are to be constructed using well established pipeline construction practices, as described in this report.

The pipeline routes cross diverse landscapes, varying from flat and arable land to mountainous and rocky regions. The pipeline routes cross several rivers, railways, highways, and smaller roads. The suitability of each crossing location and the proposed crossing technique shall be assessed and confirmed for the routes chosen in the Priority Project Portfolio.

6.1.1 Pipeline routes

The preliminary Kosovo gas transmission system layout consists of the North Macedonia - Kosovo gas interconnection, Kosovo gas ring reaching larger potential consumers, and gas transmission branches as shown in **Figure 32**. Detailed map is provided in **Annex 2**.

FIGURE 32 – PRELIMINARY LAYOUT OF THE PLANNED KOSOVO GAS TRANSMISSION PIPELINES

6.1.1.1 Gas pipeline MKD/KOS border to Prishtina

The planned North Macedonia - Kosovo interconnection (SKOPRI) is expected to be the backbone of the Kosovo gas transmission system. On the Kosovo territory, this main gas pipeline is 75,3 km long, altitudes from 535 m to 965 m (a.s.l.).

The starting point of the gas interconnection in Kosovo is the KOS/MKD border crossing point located on the northern side of Macedonian village Blace. The endpoint is the above ground facility PTS/PRMS Prishtina 2.

This pipeline is elaborated in more detail in the ongoing *Feasibility study (FS) for North Macedonia – Kosovo gas interconnection* [5].

Regarding the consumption potential, the hydraulic optimisation of the entire gas transmission system of Kosovo distinguishes 6 sections of this main gas pipeline Skopje-Prishtina which are presented and described in **Table 11**.

TABLE 11 – SECTIONS OF THE MKD-KOS GAS INTERCONNECTION

Section start – Section end, length (km)	Technical, Geological, Hydrogeological and Geotechnical description
KOS/MKD border to BVS/PRMS Smire; 17,5	At km 0,314 of MKD-KOS gas interconnection BVS Hani i Elezit is planned as a starting point of the transmission branch to Sharrcem factory. For the first 17 km, the route crosses Kaçanik mountainous part, extending north along the ridges of the eastern side of the Kaçanik gorge. After passing the area of Drenogllave the route slowly descends north direction toward Smire. At km 17,42 the BVS Smire is planned with the space reserved for future PRMS. From geologic-geotechnical aspect the terrain is composed of rock materials represented by schists, gneiss, marble, limestone, flysch sediments etc. Generally, the terrain along the alignment is stable. The excavation in the phase of construction will be mostly done in V and VI category, while low percentage in IV category (GN-200). **Comments related to types of crossed areas**: Mostly mountainous areas; altitudes 550-965 m; The corridor is mountainous but accessible by car in nearly its entire length using mountainous and unpaved roads. Southwest from Smire starts the flat agricultural area.
BVS/PRMS Smire to PTS/PRMS Ferizaj; 14,2	The route continues passing west from Viti, crosses major asphalt road R122; loops east from Ferizaj, then stretches further north crossing numerous small roads and channels. The route crosses road M25-3 and generally passes between Lipjan urban areas and highway R6. PTS/PRMS Ferizaj is planned near Ferizaj, at km 31,62 where the space for future PRMS is reserved, as well as for pig trap stations: PTS (one line) to Gjilan, PTS (one line) to Prizren. The terrain is mainly flat, composed of unbounded sediments sands, clays, at some parts also gravels, which have low density and poor diagenesis respectively. They are favourable for excavation in the phase of construction and it is expected to be in III and IV category, while at very small section in V category (GN-200). At some parts of the terrain there are recent geologic processes such as gullies and erosion of the surface material. Therefore, the foundation is recommended to be deeper than usual. Due to the high groundwater table, at some points at 1-2 m below the ground elevation, and foundation depths below the groundwater table suitable attention should be paid to the corrosion effects. Generally, the terrain can be assessed as favourable for pipeline construction. **Comments related to types of crossed areas**: Hilly, then mostly flat agricultural areas; altitudes 500-600 m; road crossings.
PTS/PRMS Ferizaj to	Section Ferizaj - Babush - Banulla, is characterised by few major road crossings. In Babush the route crosses the highway R6, then the road M2. See previous section.

Section start – Section end, length (km)	Technical, Geological, Hydrogeological and Geotechnical description
BVS Banulla; 16,2	**Comments related to types of crossed areas**: Mostly flat agricultural areas; altitudes 550-600 m; major road crossings.
BVS Banulla to BVS/PRMS Lipjan; 8,0	After BVS Banulla, the crossing of road R102 follows. Continuing north, the route crosses the road M25, turning slightly west toward the Prishtina airport area. After one railroad crossing the BVS Lipjan is located having reserved space for future PRMS. See under BVS/PRMS Smire - PTS/PRMS Ferizaj. **Comments related to types of crossed areas**: Mostly the flat area; altitudes 540-565 m; crossings of major roads and railroad.
BVS/PRMS Lipjan to PTS/PRMS Prishtina 1; 6,7	This section runs over agricultural and inhabited lands in general Sitnica River area. PTS/PRMS Prishtina 1 for the supply of the city, and the connection for the future gas pipeline branch to Drenas (Ferronikeli) is located after a crossing of Sitnica River and a railroad. See under BVS/PRMS Smire - PTS/PRMS Ferizaj. **Comments related to types of crossed areas**: The flat agricultural and inhabited areas; altitudes 535-560 m; some major crossings.
PTS/PRMS Prishtina 1 to PTS/PRMS Prishtina 2; 12,7	Continuing north the route crosses major asphalt road M9, then changes direction to the northeast toward Fushe Kosove, while crossing two railroads. The route stretches further north parallel with the Sitnica River to reach Drenica River crossing, loops west around Lismiri and continues following Sitnica River northwards, then crosses the Sitnica River again ending at the above-ground facility PRMS Prishtina 2. See under BVS/PRMS Smire - PTS/PRMS Ferizaj. **Comments related to types of crossed areas**: The flat area; altitudes 530-550 m; End of the route toward PTS/PRMS Prishtina 2, parallel with Sitnica River, HDD crossings of Drenica and Sitnica River.
Total length:	**75,3 km**

Other considered sections of the preliminary layout of the Kosovo gas transmission system are given in sections below.

6.1.1.2 Gas pipeline Ferizaj - Prizren

This transmission gas pipeline is 54,9 km long, stretching in a general East-West direction, altitudes from 350 m to 1290 m (a.s.l.).

The starting point of the pipeline is PTS/PRMS Ferizaj. The endpoint of the pipeline is PTS/PRMS Prizren.

Regarding the consumption potential, the hydraulic optimisation of the entire gas transmission system of Kosovo distinguishes 2 sections of this main gas pipeline which are presented and described in **Table 12**.

TABLE 12 – SECTIONS OF THE GAS PIPELINE FERIZAJ - PRIZREN

Section start – end, length (km)	Technical, Geological, Hydrogeological and Geotechnical description
PTS/PRMS Ferizaj to PRMS Suhareka; 39,6	The first part from PTS/PRMS Ferizaj toward the east in the length of approx. 12,9 km ends NW from the settlement Balaj and is mostly situated within the flat agricultural lands, entering inhabited areas only near the road crossings, such as the R6 highway crossing (near Sojeva), major road Ferizaj - Lipljan crossing (M2) and crossing of M25-3. Next, the corridor crosses hilly, then mountainous areas in the length of 18,8 km passing Jezerce, reaching an altitude of 1290 m. From Bukoshi to PRMS Suhareka the corridor passes flat agricultural lands and some larger objects in Suhareka, altitudes as low as 4oo m, length 7,9 km. From geomorphological aspect the terrain at km 0+000-14+400 is mainly planar (450-600m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for the construction of this type of structure. Engineering-geological processes and appearances such as washing, rilling, rockfalls, talus etc. are possible in the construction phase. **Comments related to types of crossed areas**: Flat agricultural lands combined with mountainous areas; altitudes from 420 m to 1290 m
PRMS Suhareka to PTS/PRMS Prizren; 15,3	The remaining section continues to reach PTS/PRMS Prizren. It follows highway R7 (Dr. Ibrahim Rugova) in its entire length crossing several local roads (such as one in Terrnje/Leshan). From geomorphological aspect the terrain along the entire length of the alignment, is mainly planar (320-400 m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts, synclines etc.). At several locations the alignment crosses regional and local roads as well as smaller and larger waterflows, with many settlements and mainly agricultural land. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds, whereas the appearances such as washing, rilling etc. can be rare occurrences in the phase of construction. **Comments related to types of crossed areas**: Mostly flat agricultural areas, rarely inhabited; altitudes 345 m to 420 m
Total length:	**54,9 km**

6.1.1.3 Gas pipeline Prizren - Gjakovë

This transmission gas pipeline is 28.8 km long, stretching in a general northwest direction, following the corridor of road R107 (road Prizren – Gjakovë – Pejë), altitudes from 300 m to 370 m (a.s.l.).

The starting point of the pipeline is PTS/PRMS Prizren. The endpoint of the pipeline is PRMS Gjakovë.

Regarding the consumption potential, the hydraulic optimisation of the entire gas transmission system of Kosovo distinguishes 2 sections of this main gas pipeline which are presented and described in **Table 13**.

TABLE 13 – SECTIONS OF THE GAS PIPELINE PRIZREN - GJAKOVË	
Section start – end, length (km)	**Technical, Geological, Hydrogeological and Geotechnical description**
PTS/PRMS Prizren to BVS Krushe e Madhe; 13,3	This section starting from PTS/PRMS Prizren toward the NW in the length of approx. 13,3 km ends NW from the Krushe e Madhe and follows the road R107 and outskirts of the inhabited areas near the road. The route crosses road R107 two times and the stream Topluga, From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (350-410 m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts etc.). Contemporary processes such as rilling, washing, erosion etc. Are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, railway, as well as smaller and larger waterflows (river Topluga, Korishka river, Jaglenica etc.), with many settlements and mainly agricultural land. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds whereas the appearances such as washing, rilling etc. Can be rare in the phase of construction. **Comments related to types of crossed areas**: Mostly flat agricultural areas, entering inhabited areas only near the road crossings; altitudes 300-400 m
BVS Krushe e Madhe to PRMS Gjakova; 15,5	This section continues over flat agricultural lands in the length of 15,5 km, crossing the road R107 again and the river Drini i Bardhë . Continuing along the river valley to the NW, the route reaches the town of Fshati, crosses the road R107 again, then the stream Ereniku, after which, remaining in the general corridor of R107, it reaches the eastern part of Gjakova at the above ground gas pipeline facility PRMS Gjakova. In its entire length of 15,5 km. From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (340-400m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts etc.). Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Drini I Bardhë, Ereniku and other smaller waterflows), with many settlements and mainly agricultural land. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds whereas the appearances such as washing, rilling etc. can be rare in the phase of construction. **Comments related to types of crossed areas**: Mostly flat agricultural areas crossing major road R107 twice; altitudes 300-370 m
Total length: 28,8 km	

6.1.1.4 Gas pipeline Gjakovë - Pejë

This transmission gas pipeline is 36,0 km long, stretching in a general north direction mostly over flat agricultural lands, altitudes from 370 m to 600 m (a.s.l.).

The starting point of the pipeline is PRMS Gjakova. The endpoint of the pipeline is PTS/PRMS Peja.

Regarding the consumption potential and the hydraulic optimisation of the entire gas transmission system of Kosovo distinguishes 2 sections of this main gas pipeline which are presented and described in **Table 14**.

TABLE 14 – SECTIONS OF THE GAS PIPELINE GJAKOVA - PEJA	
Section start – end, length (km)	**Technical, Geological, Hydrogeological and Geotechnical description**
PRMS Gjakova to PRMS Decani; 24,0	This section starting from PRMS Gjakova toward Decani and Peja stretches around the east side of the city along the state road M9-1, then crosses M9-1 north of Querim, and shortly after, the stream Osek. Continuing west the route crosses several local roads. On its way northwest, towards Skivjan and further Plancori, the route crosses road R107 turning west, continuing along its west side to Rastovice where it crosses road R202. South from Decani in Prilepi, the route crosses back to the east side of road R107, reaching the facility PRMS Decani, which is planned near road R201. From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (420-570 m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures. Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Trakanic, Proni mol etc.), with many settlements and mainly agricultural land. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds whereas the appearances such as washing, rilling etc. can be rare in the phase of construction. **Comments related to types of crossed areas**: Mostly flat agricultural areas; altitudes 370 m to 600 m. The section follows the corridor of road R107 in the north direction; few major road crossings
PRMS Decani to PTS/PRMS Peja; 12,0	This section continues in the general north direction. After crossing R201 the route continues following the R107 corridor, passing east from Strellc i Eperm. North from there, looping around Raushiqi the route crosses road R121, going east to reach the southeast area of Peja at the facility PTS/PRMS Peja. From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (500-540 m a.s.l.), from tectonic aspect the terrain is stable without appearance of tectonic structures. Contemporary processes such as rilling, washing, erosion etc. are well developed. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Decani etc.), with many settlements and mainly agricultural land. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion which is frequent appearance can be expected along the riverbeds, whereas the appearances such as washing and rilling are very well developed with frequent appearances of deep guillies. **Comments related to types of crossed areas**: Mostly flat agricultural areas, some populated areas; two major road crossings, altitudes 500 m to 600 m.
	Total length: 36,0 km

6.1.1.5 Gas pipeline Pejë - Istog

This transmission gas pipeline is 24,0 km long, stretching in a general northeast direction mostly over flat agricultural lands and occasionally across populated areas, altitudes from 440 m to 520 m (a.s.l.).

The starting point of the pipeline is PTS/PRMS Peja. The endpoint of the pipeline is PRMS Istog.

Starting from south-eastern Peja the route passes a flat agricultural area of Fushe, crosses the stream Lumbardhi i Pejës, then major road M9 in the narrow corridor between inhabited buildings. In continuation, the route passes near settlement Bllagaja and crosses stream Drini i Bardhë, then the road R101 looping west and north of the settlement Banja e Pejës. North from Lubova the route crosses road R103 continuing East and reaching the planned above ground facility PRMS Istog right after crossing road R104.

TABLE 15 – GAS PIPELINE PEJA - ISTOG

Section start – end, length (km)	Geological, Hydrogeological and Geotechnical description
PTS/PRMS Peja to PRMS Istog; 24,0	From geomorphological aspect the terrain along the entire length of the alignment is mainly planar with low hills (420-600 m a.s.l.), from tectonic aspect the terrain is stable without appearance of tectonic structures. Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Drini I Bardhë, river Istog etc.), with many settlements and mainly agricultural land. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds, whereas the appearances such as washing, rilling, etc. can be rare.

6.1.1.6 Gas pipeline Istog - Skenderaj

This transmission gas pipeline is 28.0 km long, stretching in a general east direction mostly over flat agricultural lands and occasionally hilly areas, altitudes from 450 m to 710 m (a.s.l.).

The starting point of the pipeline is PRMS Istog. The endpoint of the pipeline is PTS/PRMS Skenderaj.

Starting from the PRMS Istog the route crosses road R103, then starts ascending toward hill Lumbreg, continues east to cross the road R221, and reaches populated areas of Runik at altitudes of 700 m where it crosses the road R101. After that, the route continues southeast and reaches PRMS/PTS Skenderaj.

TABLE 16 – GAS PIPELINE ISTOG - SKENDERAJ

Section start – end, length (km)	Geological, Hydrogeological and Geotechnical description
PRMS Istog - PTS/PRMS Skenderaj; 28,0	From geomorphological aspect the terrain is from planar to hilly-mountaineous (470-780 m a.s.l.), from tectonic aspect the terrain is generally stable with appearance of tectonic structures (faults which cut the alignment). At several locations the alignment crosses regional and local roads as well as more larger waterflows (Lumi I Istogut river,) and other smaller waterflows. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling etc. are frequent. The landslide process is well expressed at the part of v. Chitak to Rudnik. At this part of the alignment in the phase of detailed investigations more attention should be paid.

6.1.1.7 Gas pipeline Prishtina 1 - Drenas

This transmission gas pipeline is 14,7 km long, altitudes from 555 m to 686 m (a.s.l.)

The starting point of the pipeline is PRMS Prishtina 1, located on the MKD-KOS interconnection pipeline. The endpoint of the pipeline is PRMS Drenas (Ferronikeli) in the vicinity of the Ferronikeli factory.

At its beginning, the route runs in a westerly direction, passing over flat, agricultural terrain. The route crosses the access road to Prishtina airport and a local road. The next part of the pipeline passes through a low, oak forest on hilly terrain, crosses the M9 (R7) highway. In continuation, the route mostly follows the newly built road to Drenas, and shortly before its endpoint (near the Ferronikeli factory) the Drenice River, in two locations.

TABLE 17 – GAS PIPELINE PRISHTINA 1 - DRENAS

Section start – end, length (km)	Geological, Hydrogeological and Geotechnical description
PTS/PRMS Prishtina 1 to PRMS Drenas (Ferronikeli); 14,7	From geomorphological aspect the terrain is from planar to hilly-mountaineous (550-700m a.s.l.), from tectonic aspect, the terrain is stable with appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling etc. are less pronounced.

6.1.1.8 Gas pipeline Drenas - Skenderaj

This transmission gas pipeline is 17,7 km long, stretching in a general northwest direction mostly over hilly agricultural lands between the settlements, altitudes from 600 m to 690 m (a.s.l.).

The starting point of the pipeline is PRMS Drenas. The endpoint of the pipeline is PTS/PRMS Skenderaj.

Starting at PRMS Drenas in the vicinity of the Ferronikeli factory the route crosses several local roads and the road R102, then following northwest direction reaches southern outskirts of Skenderaj, runs across populated and hilly areas east from the town to end at facility PTS/PRMS Skenderaj.

TABLE 18 – GAS PIPELINE DRENAS - SKENDERAJ

Section start – end, length (km)	Geological, Hydrogeological and Geotechnical description
PRMS Drenas (Ferronikeli) to PTS/PRMS Skenderaj; 17,7	From geomorphological aspect the terrain is from planar to hilly-mountaineous (550-730m a.s.l.), from tectonic aspect, the terrain is stable with appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows. Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling etc. are less pronounced.

6.1.1.9 Gas pipeline Skenderaj - Mitrovicë

This transmission gas pipeline is 16,5 km long, stretching in a general northeast direction mostly over hilly agricultural lands between the settlements, altitudes from 500 m to 780 m (a.s.l.).

The starting point of the pipeline is PTS/PRMS Skenderaj. The endpoint of the pipeline is PRMS Mitrovica.

Starting from PRMS/PTS Skenderaj the route crosses the road R102 in Klina, then following northeast direction between settlements reaches Verbnica and Leskova, passes the hilly forested area, then flat agricultural area crossing several local roads, reaches southern outskirts of Kosovska Mitrovica where right after the crossing of road R220 the gas pipeline facility PRMS Mitrovica is planned.

6.1.1.10 Gas pipeline Mitrovicë - Vushtrri

This transmission gas pipeline is 7,2 km long, stretching in a general southeast direction over very flat agricultural lands between the Sitnice River valley and the common corridor of railroad and road R220. The route starts at PRMS Mitrovica and ends at the PTS/PRMS Vushtrri, crossing roads 511 and R220 shortly before that. Altitudes from 500 m to 513 m (a.s.l.)

6.1.1.11 Gas pipeline Ferizaj - Gjilan

This transmission gas pipeline is 24,9 km long, altitudes from 495 m to 655 m (a.s.l.).

The starting point of the pipeline is PTS/PRMS Ferizaj, located on the MKD-KOS interconnection pipeline. The endpoint of the pipeline is PTS/PRMS Gjilan.

At its beginning, this route runs in the southeast direction parallel to MKD-KOS interconnection pipeline, but just before the crossing of the road M25-3, it turns east, bypasses the town of Dardania on its north side, then Novosellë. Turning southeast, the route also bypasses Pozherani on its northern side, after which it turns sharply to the northeast, continuing in the general corridor of the road M25-3 reaches Parteshi and the southwestern part of Gjilan. This route does not cross any state and regional roads, but only local roads and a few streams~~.~~

6.1.1.12 Gas pipeline Gjilan - Kamenicë

This transmission gas pipeline is 26 km long, altitudes from 468 m to 800 m (a.s.l.)

The starting point of the pipeline is PTS/PRMS Gjilan. The end point of the pipeline is PRMS Kamenicë.

At its beginning, this route runs in the south direction passing east from the settlement Livoqi i Ulte, crosses the road M25-3, looping around southern Gjilan over flat agricultural areas and crosses the road B35. After turning north toward Kamenicë the route crosses M25-3 again, passes east from Prelepnica entering hilly and mountainous area. Over Rajanoc the route reaches Berivojce where the above ground facility PRMS Kamenica is planned.

6.1.1.13 Gas pipeline Krushë e Madhe - Rahovec

This transmission gas pipeline is 8,0 km long and runs in a general north direction over mostly flat agricultural areas, altitudes from 300 m to 436 m (a.s.l.)

The starting point of the pipeline is BVS Krushë e Madhe, located near road R107 at the pipeline Prizren - Gjakovë. The endpoint of the pipeline is PRMS Rahovec.

On its way, this route passes east from Celina crossing a few local roads, before it crosses road 110 and reaches the planned location of PRMS Rahovec at the west side of the town.

6.1.1.14 Gas pipeline Rahovec - Malishevë

This transmission gas pipeline is 12,0 km long and runs in a general northeast direction, altitudes from 390 m to 800 m (a.s.l.)

The starting point of the pipeline is PRMS Rahovec, located near road R107 at the pipeline Prizren - Gjakove. The endpoint of the pipeline is PRMS Malishevë.

On its way, this route passes mostly hilly areas in a wider corridor of road 110, which is crossed two times before thig transmission gas pipeline branch reaches the PRMS Malishevë.

6.1.1.15 Gas pipeline Ferizaj - Shtime

This transmission gas pipeline shall be 15,0 km long and runs in a general northeast direction over flat agricultural areas, altitudes from 550 m to 583 m (a.s.l.)

The starting point of the pipeline is PTS/PRMS Ferizaj, located on the MKD-KOS interconnection pipeline. The endpoint of the pipeline is PTS/PRMS Shtime.

On its way, this route first passes mostly flat agricultural areas sharing the common corridor with the pipeline Ferizaj – Prizren. Shortly after crossing the motorway M2, the route reaches Bublice, turns northwest direction following wider corridor of M25-3 east from Slivovo and then Koshare where it crosses road R207. North from there, the route turns west to reach the eastern outskirts of Shtime.

6.1.1.16 Gas pipeline Pejë - Klinë

This transmission gas pipeline is approximately 25,0 km long and runs in a general east/southeast direction mostly over flat agricultural lands, altitudes from 364 m to 516 m (a.s.l.)

The starting point of the pipeline is PTS/PRMS Peja. The endpoint of the pipeline is PRMS Klinë.

From the southeastern parts of Peja this route runs east toward Jabllanice then southeast following the wider corridor of motorway M2, crossing R121 in Grabanice, looping north around Zajm crossing the river Drini i Bardhë, railroad, and motorway M2, to reach the southern outskirts of Klinë.

6.1.1.17 Gas pipeline to Kaçanik

This transmission gas pipeline is approximately 3,4 km long and runs in a general west direction mostly over hilly areas, altitudes from 570 m to 915 m (a.s.l.). For this branch to be realised it is necessary to plan a new facility (as the starting point) at the MKD-KOS gas interconnection which is BVS Kaçanik. The endpoint of the branch would be PRMS Kaçanik.

From the newly planned location of BVS Kaçanik this route descends west toward Lirishte (Lanishte) continuing northwest following local roads along the ridges, to reach the eastern outskirts of Kaçanik without any significant crossings.

6.1.1.18 Gas pipeline Prizren - Dragash

This transmission gas pipeline is approximately 26,0 km long, and runs generally in the south direction partly over hilly/mountainous and partly over flat agricultural areas, altitudes from 322 m to 1058 m (a.s.l.).

The starting point is the PTS/PRMS Prizren and the endpoint of the branch would be PTS/PRMS Dragash.

From the populated areas of north-western Prizren, the route passes flat areas toward Vlashnje following the wider corridor of highway E851 (Dr. Ibrahim Rugova). Turning south the route reaches hilly and soon mountainous areas crossing R113 twice and following its corridor along the mountain ridges to Dragash.

6.1.1.19 Gas pipeline Prishtinë - Podujevë

This transmission gas pipeline is approximately 33,0 km long and runs generally in the northeast direction over flat agricultural areas, altitudes from 322 m to 1058 m (a.s.l.). The starting point is the PTS/PRMS Prishtina 2 and the endpoint of the branch is PTS/PRMS Podujevo.

This branch crosses from the planned PTS/PRMS Prishtina 2 location over to the west bank of Sitnica River in order to loop around the industrial complex of TPP Kosova B and turn east direction. On its way towards Millosheva the route crosses R220. In continuation, the route passes south from Millosheva crossing road M2, then follows the road to Prugoc, turning northeast, crosses that road, and enters wider corridor of regional motorway M25 and the railroad where it passes flat agricultural areas in the valley of LLapi River between the settlements. In Shakovice the route crosses M25 and continues following it on the east side. In the vicinity of Siboc the route crosses the railroad and back, continuing to enter the southern outskirts of Besiana (Podujevë).

6.1.1.20 Gas pipeline Suharekë - Mamushë

This transmission gas pipeline is approximately 8,0 km long and runs generally in the west direction over flat agricultural areas, altitudes from 330 m to 420 m (a.s.l.). The starting point is the PRMS Suhareka and the endpoint of the branch is PRMS Mamushë.

The first 4,0 km of this route shares the same corridor with the pipeline Ferizaj – Prizren along the highway R7 passing over very flat agricultural areas. Passing north from Ternja the route for the next 4,0 km continues along the local road and reaches the eastern outskirts of Mamushë.

6.1.1.21 Gas pipeline BVS Hani i Elezit to Sharrcem

This transmission gas pipeline shall supply the Sharrcem cement factory, one of the main likely anchor-loads for gas use in Kosovo and is approximately 2,72 km long, altitudes vary from 390 m to 675 m.

This pipeline starts at the BVS Hani i Elezit which is planned at km 0,314 of MKD-KOS gas interconnection. The endpoint of the branch would be PRMS Hani i Elezit (Sharrcem).

The entire route is located near the MKD border. It starts in a forest area and on a hilly terrain near the village of Dimca, descends in a southwesterly direction toward the settlement of Hani i Elezit, and passes between the quarry and the Konop stream, rising over a steep slope at the end to the top of the hill and the proposed PRMS Hani i Elezit (Sharrcem) location.

6.1.1.22 Gas pipeline Prizren – ALB/KOS border

This transmission gas pipeline is approximately 20,0 km long, and from the ALB/KOS border connection point runs generally in the northeast direction over the populated areas in the corridor of the major highway Kukes-Prishtina, E851 (R7). Altitudes vary from 310 m to 530 m (a.s.l.)

The starting point is the ALB/KOS border connection point and the endpoint of the section is PTS/PRMS Prizren. The comparable route of this section is planned within the pre-feasibility study of the gas interconnection ALKOGAP and as such is considered a part of the Kosovo Gas Development Plan.

The corridor crosses the highway Kukes-Prishtina E851 (R7) three times, at different locations. From its start, at the border interconnection point, the pipeline runs toward Vermicë, continues over a rugged hill near Zhur Village, and then proceeds through flat lands south from Vlashnje. The corridor crosses the major highway Kukës – Prishtina between Zhur and Vlashnje Village and it remains on its northern side until reaching PTS/PRMS Prizren.

6.2 Technical considerations for hydrogen (H_2)-ready infrastructure

For the time being, there are neither high pressure and large diameter main gas pipelines built to transport natural gas that are repurposed to transport pure hydrogen, nor are there appropriate new main pipelines built for the transport of pure hydrogen and operated by TSO-s. The current industrial practice is to transport mixtures of different proportions of natural gas and hydrogen.

6.2.1.1 Current H_2 blending limits in EU

Agency for the Cooperation of Energy Regulators (ACER) received responses from the 23 National Regulatory Authorities[21] (NRA) regarding national regulation for Hydrogen (H_2) content in natural gas pipelines (ACER Report on NRAs Survey - Hydrogen, Biomethane, and Related Network Adaptations; 10/7/2020).

[21] *Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain and Sweden*

Results show that in most Member States (MS) the Transmission System Operators' (TSO) acceptance of H_2 is in an "exploration" phase. Where instances of H_2 injection into the gas transmission network exist, they are generally innovative pilot projects implemented in order to gain experience, knowledge, and insights.

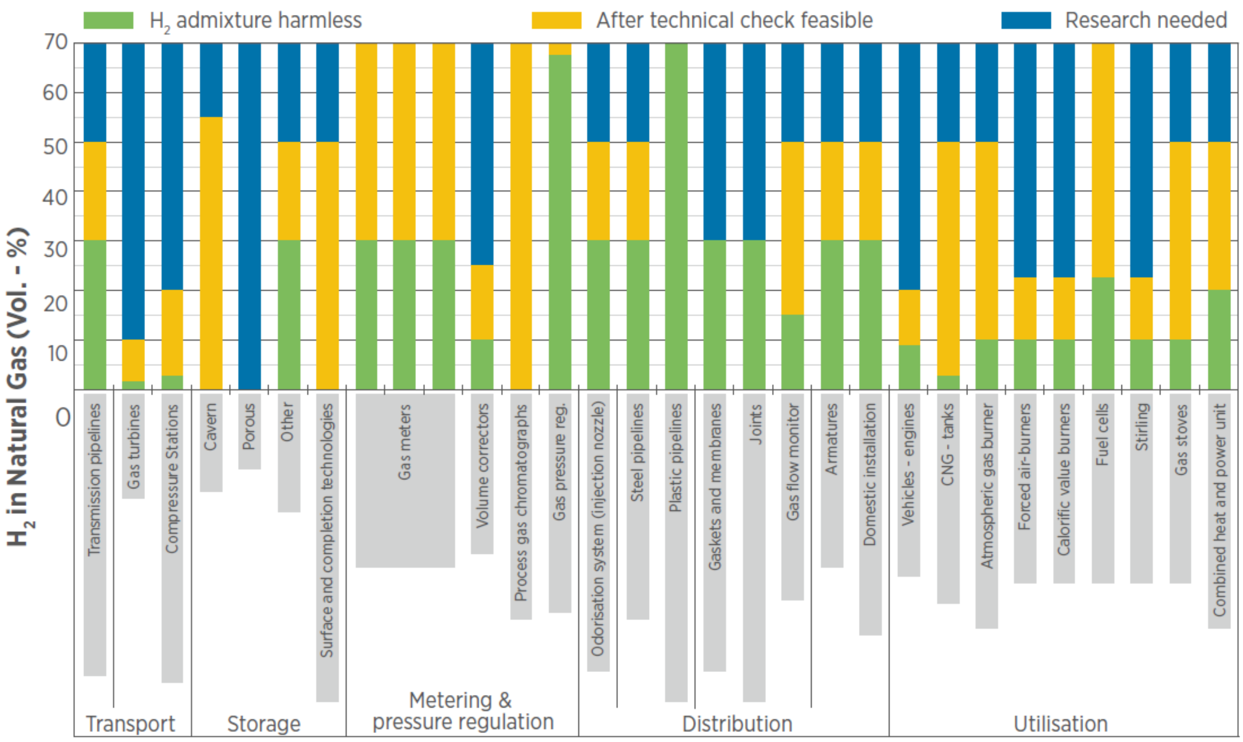
Insights from industrial scale projects resulting in the injection of H_2 in gas transmission networks are not yet available in the European Union, which indicates the relatively early stage of development of these technologies. This status quo is important for understanding the answers received from the NRAs. The answers also provide some information on ongoing projects related to H_2 blending and 100% H_2 dedicated networks.

Currently, 15 out of 23 NRAs report that TSOs in their domain do not accept the injection or allow[22] H_2 volumes into the gas transmission network. Where H_2 is explicitly accepted (Austria, Germany, Latvia, Slovakia, Spain, and Sweden), it is only possible at very low concentration by volume [4] .

In many MS, TSOs are assessing the technical constraints and necessary measures to cope with different volumes of H_2 in the gas transmission network. The level of ongoing work in terms of studies and analyses differs across the European Union. In order to enable H_2 blending, investments are needed, in particular with respect to gas quality measurement systems. In most MS current gas quality standards do not mention H_2 volumes [4].

The 2018 *IRENA study on Hydrogen from renewable power* concludes that generally up to 10-20% of hydrogen in volume likely does not require major investment. **Figure 33** illustrates the hydrogen tolerance of various gas infrastructures components [6]. Current gas end users installations and equipment generally does not tolerate significant variations in H_2/NG blends.

FIGURE 33 – HYDROGEN TOLERANCE OF GAS INFRASTRUCTURE COMPONENTS



Source: Adapted from DVGW (2012).

[22] H_2 may be present in imported gas, although not directly injected

Germany reports the highest H_2 concentration limit at gas transmission level (10%), followed by France (6%), Spain (5%), and Austria (4%). Four more countries allow for a more modest H_2 concentration in their natural gas transmission networks: Lithuania (2%), Italy (1%), Latvia (0.1%), Ireland (0.1%), and the Netherlands (0.02%). In Slovakia, there is no explicitly defined H_2 limit; however, H_2 can be present in imported gas (up to 2% maximum), but not directly injected into the network. In more than 60% of MS, the current H_2 concentration limit is nil (0%) [4].

As regards the main reasons to set a certain H_2 concentration limit, gas quality requirements, safety, and tolerances of end-use equipment are commonly cited. The most common reasons to limit H_2 concentration in the gas transmission network are:

the regulatory framework is currently based on 0% H_2 acceptance,

sensitivity of specific industrial processes to the presence of H_2,

engine, and turbine specifications (some of them allow a concentration of up to 1% H_2),

natural gas vehicles (NGV) charging stations limits (2% H_2 allowed),

technical tolerances of network components in the gas networks,

considerations related to the safe operation of underground gas storages,

safety concerns

In most MS there are currently no H_2 blending targets for their TSOs, although in some MS (Austria, Belgium, France, Ireland, and Luxembourg) there are ongoing studies and discussions on possible blending targets. Some TSOs are promoting specific H_2 blending targets (e.g. French TSOs promote a 10% blending target by 2030, in Austria a 10% volume target is under discussion).

Most NRAs agree that H_2 blending limits should be decided at EU level rather than at the regional or bilateral level, given that cross-border gas flows should not be impeded by different H_2 blending limits at the transmission level, potentially impairing the interoperability of the gas networks. There are 9 NRAs that appear to agree on the setting of a H_2 blending limit of at least 2% concentration. However, 3 NRAs (Austria, Germany, and France), in addition to blending, stress also the importance of creating dedicated 100% H_2 networks to optimise the economic value of H_2. Priority should be given to the direct use of 100% H_2 in dedicated networks, while also making possible the development of H_2 admixtures in existing natural gas networks.

6.2.1.2 Energy carried in 100% hydrogen pipelines

Hydrogen has a low molar mass and consequently low density. Therefore, a higher amount of energy is required for its compression process. On the other hand, low pressure drops allow minimizing the number of compressor stations used for hydrogen transport, or transport of hydrogen at higher velocities while maintaining low pressure drop. Hydrogen, as an additive in natural gas, has a positive impact on pipeline transportation of natural gas which can be transported for longer distances. The important issue for hydrogen pipeline transportation is its energy value. Although combustion heat of hydrogen per mass unit is much higher (141,9 MJ/kg) than methane (54 MJ/kg), the lower density of hydrogen results in its lower heat of combustion per volume unit (12,67 MJ/ Nm^3) in normal conditions than methane (38,55 MJ/ Nm^3). The amount of energy transmitted by pipeline decreases with the increase of hydrogen content (molar fraction) in the mixture. Thus, despite better conditions for pipeline transportation, increased content of hydrogen reduces the energy efficiency of natural gas transmission. Despite the low pressure drops pure hydrogen transportation is less energy efficient than transmission methane or natural gas.

Even though the energy content per volume, MJ/m^3, of hydrogen is 1/3 of the energy content of natural gas, its energy flow rate, MJ/s, is approximately 70-75% of the natural gas energy flow rate (or 87-91% based on higher heating value) [7]. In the pipeline of equal characteristics and size, less energy dense (MJ/m^3) hydrogen could flow at a higher velocity than natural gas and could deliver 70-75% of the energy of natural gas. Despite that, the dimensioning of the pipelines within this assignment is carried out in accordance with the volumes of natural gas required to transport the necessary energy. This is because it is expected that a certain portion of hydrogen would be locally produced and would not be transported through transmission system pipelines, but either through dedicated hydrogen pipelines or via rail or road transport.

6.2.1.3 Technical issues of hydrogen and methane mixtures - in pipeline transmission

Hydrogen is commonly considered a gas similar to methane, the main component of natural gas. Therefore, most technological requirements for hydrogen transmission pipelines are identical to those of natural gas pipelines, with certain modifications regarding safety, infrastructure, and materials. These conditions must be met before the transmission of hydrogen is initiated through a pipeline network. H_2 has its specific set of physical and chemical properties which makes the pipeline transmission more demanding than transmission of natural gas.

Industrial practice and scientific publications indicate that the maximum admissible molar fraction of hydrogen in a mixture with natural gas should not exceed 15%, for safety reasons given the condition of existing pipelines as well as the current development state of H_2 technology. The maximum hydrogen content in the natural gas transmission system suggested in the United States should be in the range of 5%–15%.

Hydrogen significantly influences natural gas transmission conditions. The basic advantage is lowering the pressure drop of natural gas transmitted with a hydrogen admixture, and the possibility to transmit natural gas across longer distances without additional gas compression stations. Analysis of the hydrogen molar fraction in the hydrogen/methane mixture confirms the effect of pressure drop in the analysed pipeline. The required inlet pipeline pressure, for a 15% hydrogen content in the gas mixture, is approximately 10% lower when compared to pure methane, thus hydrogen – methane mixtures can be transported at higher flow rates and maintain the same pressure drop as pure methane. However, hydrogen content above 15%–20% in the gas mixture significantly influences the caloric value of natural gas [8]. The change in thermodynamic conditions with an increased hydrogen content may also affect the natural gas transmission system (i.e., gas compression stations or gas reduction stations).

6.2.1.4 Hydrogen-ready pipes and materials

Carbon steel is the alloy family most commonly used in hydrogen gas transmission pipelines. The choice of the specific grade will depend on many factors including the severity of the service, availability, and relative cost.

In general, the common carbon steel piping grades such as API 5L X52 (and lower strength grades) and ASTM A 106 Grade B have been widely used in hydrogen gas service with few reported problems. This good service is attributed to the relatively low strength of these alloys, which imparts resistance to hydrogen embrittlement and the other brittle fracture mechanisms.

The applicable US ASME design standard sets limitations for high strength steel use for hydrogen pipelines and limits the allowable hoop stresses on pipe walls[23]. This results in a heavier wall thickness and consequently higher construction costs.

More recent investigations have shown that hydrogen-induced crack propagation under fatigue loading does not depend on material strength. From this, it was concluded that the design constraint for higher-strength steels is overly conservative and not justified. As a result of these studies, the new version of ASME B31.12 will no longer include restrictions relating to higher strength steels.

Even in line with the current ASME B31.12, smaller diameter hydrogen ready pipelines are not expected to be materially more expensive in comparison to natural gas pipelines because at the pressure (50 bar) and diameter (up to DN 300, 12”) low grade steels would be the material of choice for both NG and H_2 pipelines. For that reason, the applicable standard will have no impact on material selection just a minor impact on wall thickness.

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[23] Consultant relies on American ASME standards as European standards do not provide clear requirements for material selection for hydrogen ready pipelines.

For larger diameter pipelines, high grade steel becomes more favourable material for NG pipelines, while H_2 pipelines are designed with low grade steel but thicker wall.

It is expected that hydrogen ready in line equipment (valves, filters, meters) will be up to 50% more expensive than in line equipment for natural gas. Nevertheless, since the in-line equipment participates in a total pipeline construction cost with less than 1%, this price difference is not crucial. The suggested approach for this project is to install the equipment for the natural gas, and when the hydrogen concentration in the pipeline exceeds predefined thresholds (currently estimated at 20%), to consider whether the equipment is still suitable and to replace gaskets and valve packing if necessary.

In the recent North Macedonia – Kosovo gas interconnection FS, pipeline having a diameter of DN500 (20"), an estimate of the investment costs for different qualities of pipe material was made in relation to whether the pipeline will transport natural gas or be 100% hydrogen ready. There, for the natural gas pipeline API 5L X60 pipe material is selected and for hydrogen ready pipeline API 5L X56 pipe material is selected, which resulted in a slightly greater wall thickness. Considering CAPEX, it was concluded that API 5L X56 material has slightly lower material prices (€/kg) than API 5L X60 (approx. 2,5%), but the weight of the pipe is greater due to greater wall thickness (app 10%) for given conditions. Considering other costs that remain the same (civil works, pipeline equipment, design, etc.), hydrogen ready pipelines result in in overall CAPEX being approximately 3% higher.

That does not include the additional cost of adjusting ground facilities to a "100% hydrogen ready" level. Taking into account the limited operational life of ground facilities (on average 20 years), it is recommended to consider the adjustment of ground facilities for a later point in time when the hydrogen concentration in the pipeline exceeds 20%. As previously mentioned, the transport of 100% of hydrogen through the envisaged pipelines would decrease the overall amount of energy transmitted to approx. 75% of the energy that would be transmitted with natural gas.

6.3 Preliminary hydraulic calculations

6.3.1 Methodology

To determine the preliminary pipeline diameters for the Kosovo transmission system, the initial hydraulic calculations have been conducted including all considered consumption centres as shown in Chapter **7.3** and the transmission network presented in Chapter **6.1.1** and **Figure 32**. Consumptions in these consumption centres are given in Chapter **4.1** and are presented in the Basic Block Flow Diagram in **Annex 1**.

The basis for initial hydraulic calculations was the current finding from the *MKD-KOS gas interconnection FS* [5], where the diameter of that main transmission pipeline has been determined, DN600 (24").

6.3.2 Standard conditions and gas quality

6.3.2.1 Standard conditions

The following standard gas conditions are envisaged in the hydraulic calculation:

Standard Pressure: 1.01325 bar

Standard Temperature: 15°C.

6.3.2.2 Gas properties

The gas composition provided by Beneficiaries is representative of gas from Natural gas composition shown in **Table 19** and corresponds to the gas composition of the Trans Adriatic Pipeline (TAP) according to *AE Prefeasibility Study – 2019/2020 Kosovo Compact Energy Sector* [9]. TAP gas composition is used under the assumption that the majority of natural gas in Kosovo would be coming from Greece – North Macedonia interconnection. Greece is supplied with natural gas from TAP/TANAP. In any case, natural gas from other sources is expected to have similar composition as well.

For the purposes of this assignment, the TAP gas is considered as default, and its content is provided in the table below. The process calculations are based on the following gas composition.

TABLE 19 – NATURAL GAS COMPOSITION

Component		Mole, %
Methane	C1	87,78
Ethane	C2	2,72
Propane	C3	1,54
Iso-Butane	C4	0,50
N-Butane	C4	0,51
Iso-Pentane	C5	0,24
N-Pentane	C5	0,24
Hexane	C6	0,03
Nitrogen	N2	4,43
Carbon Dioxide	CO2	2,01
Total		**100**

6.3.3 Pipeline related data

Input pipeline related data for newly designed pipelines hydraulic calculations is provided in **Table 20**.

TABLE 20 – PIPELINE RELATED DATA

Pipeline related data	
Design pressure	50 bar
Material standard	API 5L Gr.B ; (4"-10") API 5L X56; (20")
Roughness(1):	0.05 mm
The soil temperature at laying depths(1):	10°C
Pipe wall thickness(2):	ASME B31.12
1 **Assumed value for hydraulic calculations**	
2 **In hydraulic calculations average wall thickness is used**	

6.3.4 Design pressure

The hydraulic analysis took into account the minimum required pressure to supply the future CCGT (requiring 30 barg) which shall be supplied from the end point of the pipeline (PRMS Prishtina 2), and the minimum required inlet pressure in Northern Macedonia (50 barg) which would enable the transport of the required gas quantities.

These values were already determined in the current *MKD-KOS gas interconnection FS* [5], including the diameter of the main transmission pipeline, enabling the transport of the required gas quantities.

6.3.5 Wall thickness calculation

Pipe wall thickness calculations have been performed per ASME B31.12.

6.4 Preliminary transmission system CAPEX and OPEX estimates

Based on the proposed routes, their characteristics, technological and technical requirements and construction methods, the investment costs were determined. Using experience on similar regional projects in the last five years (the concept of comparison), the rough/preliminary unit prices per meter of the gas pipeline were applied, considering terrain characteristics as well as the crossings of different obstacles (roads, railroads, watercourses, steep areas) and crossing construction methods. The investment costs include materials and installation/construction costs, whereby different professional disciplines are considered: mechanical, civil with geodesy, architectural, cathodic protection, optical communication system, as well as the commissioning, permissions, management, design, engineering, and supervision.

Transportation to the site, necessary loading, and unloading, material storage at the site, all required preliminary works (cleaning, repairs, prefabrication, etc.), welding, welds radiographic testing, hydrostatic testing, and necessary documentation are covered under construction (Installation) works.

The average costs for the easement and different compensations costs for buildings or crops, temporary lease of land required for the working strip during the construction was considered in the estimated price for each section as well.

Based on the experience on similar regional projects in the last five years, the estimated total prices per gas pipeline facility type were applied. These totals include materials and installation/construction costs, whereby different professional disciplines are considered: mechanical, civil with geodesy, architectural, cathodic protection, electrical, as well as the commissioning, permissions, management, design, engineering, and supervision. Installation/construction costs cover transportation to the site, necessary loading and unloading, material storage at the site, all required preliminary works (cleaning, repairs, prefabrication, etc.), welding, welds radiographic testing, hydrostatic testing, and necessary documentation. The roughly estimated costs for purchasing the land are considered within the total estimated cost for each typical facility.

Estimates are given for the piping material choice that enables the transport of natural gas and hydrogen as well. The additional cost of adjusting ground facilities (valves, gaskets, etc.) to a "100% hydrogen ready" level is not included. The consultant recommends considering the adjustment of ground facilities for a later point in time when the hydrogen concentration in the pipeline exceeds 20%. At that time, the operator shall analyse whether the equipment is still suitable and replace the gaskets and valves if necessary.

The 75,3 km of planned North Macedonia - Kosovo interconnection (SKOPRI) is expected to be the backbone of the Kosovo gas transmission system and CAPEX estimates from the ongoing *North Macedonia – Kosovo gas interconnection FS* [5] were considered for the first 6 sections.

In assessing costs, the Consultant used the current market prices. Covid pandemic driven disruption in supply chains caused the global shortage of steel that impacts the pipeline material costs. War in Ukraine has driven the steel prices further upwards. Actual investment costs may significantly differ from the ones assessed here, depending on the market situation at the time of pipeline tendering.

Estimated annual operating costs (OPEX) include costs of labour, maintenance, and insurance. At this point the Consultant estimates annual OPEX at 1,0 % of total capital investment cost.

Estimated CAPEX is provided in **Table 21**. It is based on calculated preliminary capacity requirements (resulting from provisional system block flow diagram model, see **Annex 1**) and resulting preliminary pressures (estimated from a provisional hydraulic model, see **Annex 1**).

TABLE 21 – PRELIMINARY CAPEX FOR ALL INITIALLY DEVELOPED TRANSMISSION PIPELINES

	No	Municipality	District	Section	Length (km)	Diam. (inch)	Total (mil €)
MKD/KOS interconn.	1	Kaçanik	Ferizaj	MKD/KOS Border - BVS/PRMS Smira	17,5	24	18,859
	2	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	24	13,212
	3	Shtime	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	24	13,671
	4	Lipjan	Prishtinë	PRMS Banulla - BVS/PRMS Lipjan	8,0	24	7,672
	5	Prishtinë	Prishtinë	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	24	6,636
	6	Obiliq	Prishtinë	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	24	12,228
				SUBTOTAL MKD/KOS Interconnection:	**75,3**		**72,278**
Gas ring	7	Shtime	Ferizaj	PTS/PRMS Ferizaj - PRMS Suharekë	39,6	10	**19,623**
	8	Suharekë	Prizren	PRMS Suharekë - PTS/PRMS Prizren	15,3	10	**6,366**
	9	Prizren	Prizren	PTS/PRMS Prizren - BVS Krushe e Madhe	13,3	10	**6,369**
	10	Gjakovë	Gjakova	BVS Krushe e Madhe - PRMS Gjakova	15,5	10	**6,197**
	11	Deçan	Gjakovë	PRMS Gjakova - PRMS Decan	24,0	10	**8,800**
	12	Pejë	Peja	PRMS Decan - PTS/PRMS Peja	12,0	10	**5,535**
	13	Istog	Peja	PTS/PRMS Peja - PRMS Istog	24,0	10	**10,995**
	14	Skenderaj	Mitrovica	PRMS Istog - PTS/PRMS Skenderaj	28,0	10	**12,598**
	15	Gllogoc	Prishtina	PRMS Drenas - PTS/PRMS Skenderaj	17,7	10	**8,675**
	16	Fushë Kosovë	Prishtina	PTS/PRMS Prishtina 1 - PRMS Drenas	14,7	10	**8,389**
				SUBTOTAL Gas ring:	**204,1**		**93,544**
Transmission branches	17	Mitrovicë	Mitrovica	PTS/PRMS Skenderaj - PRMS Mitrovica	16,5	6	**6,545**
	18	Vushtrri	Mitrovica	PRMS Mitrovica - PTS/PRMS Vushtrri	7,2	6	**2,808**
	19	Ferizaj	Ferizaj	PTS/PRMS Ferizaj - PTS/PRMS Gjilan	24,9	6	**8,653**
	20	Kamenice	Gjilan	PTS/PRMS Gjilan - PRMS Kamenice	26,0	4	**7,412**
	21	Rahovec	Gjakova	BVS Krushe e Madhe - PRMS Rahovec	8,0	4	**2,352**
	22	Malishevë	Prizren	PRMS Rahovec - PRMS Malisheve	12,0	4	**4,422**
	23	Shtime	Ferizaj	PTS/PRMS Ferizaj - PTS/PRMS Shtime	16,7	4	**5,161**
	24	Klinë	Peja	PTS/PRMS Peja - PTS/PRMS Kline	25,0	4	**8,164**
	25	Kaçanik	Ferizaj	BVS Kacanik - PRMS Kacanik	4,0	4	**1,980**
	26	Dragash	Prizren	PTS/PRMS Prizren - PTS/PRMS Dragash	26,0	4	**9,924**
	27	Podujevë	Prishtina	PTS/PRMS Prishtina 2 - PTS/PRMS Podujevo	33,0	4	**9,927**
	28	Mamushë	Prizren	PRMS Suhareka - PRMS Mamushe	8,0	4	**2,352**
	29	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit (Sharrcem)	2,7	4	**1,989**
				SUBTOTAL Transmission branches:	**210**		**71,687**
				TOTAL Kosovo Gas transmission system:	489,4		237,5085

7 TECHNO-ECONOMIC ASSESSMENT OF THE DISTRIBUTION SYSTEM

7.1 Gas distribution system basics

Gas distribution systems of cities and other settlements usually consist of the following components (looking in the direction of gas flow):

odorising station with connecting pipeline from PRMS;

the high pressure (HP) distribution pipeline

medium-pressure (MP) gas network

MRS of low pressure (LP) gas network

low pressure (LP) gas network

The permitted range of working gas pressure in the distribution system (limited by minimum and maximum working pressure) at which gas distribution takes place is divided into three classes:

low pressure (up to and including 0,1 bar),

medium pressure (0.1 bar up to and including 5 bar) and

high pressure (more than 5 bar)

The distribution system starts from a pressure reduction and metering station (PRMS), which normally is the property of the transmission system operator (TSO).

The PRMS owned by the TSO generally has two outputs to the gas distribution systems: one at which the pressure is reduced to 5 bar (for MP gas network supply) and another at which the pressure is reduced to 16 bar (for HP distribution pipeline supply).

The odorizing station (OS) normally owned by the gas distributor (DSO) is built at an appropriate location, often near a metering and regulation station (MRS). The purpose of having an OS is gas odorizing because natural gas is colourless, odourless and tasteless, so an odorant of characteristic smell is added, to enable the detection of gas presence by sense of smell. Gas odorizing is to be performed in accordance with the applicable technical regulation "Odorizing of gas".

MP and LP gas supply system enables full gasification (gas as fuel for heating, hot water, cooking, and cooling) of existing and future objects, while HP distribution pipelines typically are used for gas supply of large, mainly industrial consumers, or to transport gas to the MRS in remote parts of the city or village.

MP and LP gas pipelines are made from the polyethylene pipes manufactured and tested according to applicable standards such as EN 1555 Plastics piping systems for the supply of gaseous fuels -- Polyethylene (PE) -- Part 2: Pipes (EN 1555-2) Standard pipes and fittings are quality PE 100, while section sizes and classes (SDR) comply with the working and test conditions.

HP distribution pipelines are made of steel pipes manufactured and tested according to applicable standards: EN 10208-2 Steel pipes for pipelines for combustible fluids -- Technical delivery conditions -- Part 2: Pipes of requirement class B (EN 10208-2). The quality and thickness of the wall comply with the working and test conditions.

The final dimensions of the gas distribution pipelines are determined by hydraulic calculations in the preliminary or detailed design stage.

Gas distribution pipelines are mainly laid in public roads, parallel with other utility infrastructure.

MP and LP pipelines are typically buried with a minimal ground cover of 0.80 m while HP gas pipelines are buried with a minimal ground cover of 1.0 m. The width of the pipeline trench is typically from 0.40 to 0.70 m. Polyethylene gas distribution pipes are laid on a sand bed, approximately 15 cm thick.

After laying and testing the pipeline, the trench is backfilled with fine sandy material to a certain level above the pipe. Above the sand backfilling is done with gravel in layers until the surface sub-base. Surfaces, such as pavement, sidewalks, and green areas are then restored to their original state.

The pipeline distance from buildings, other above ground structures, and parallel underground utility installations, as well as crossings of other utility installations, complies with the rules and standards for the pipeline installation, such as Technical rules Steel pipelines for maximum operating pressure over 16 bar, EN 1594 Gas infrastructure -- Pipelines for maximum operating pressure over 16 bar -- Functional requirements (EN 1594), Technical rules: Steel pipelines for maximum operating pressure over 5 bar – Maintenance and EN 12007-1 Gas infrastructure -- Pipelines for maximum operating pressure up to and including 16 bar -- Part 1: General functional requirements.

Pipeline crossings of railways and main roads are usually performed by methods of drilling at a required depth while typical technical solutions of pipeline crossings with watercourses include open trench methods, i.e. burying the pipeline at the proper depth below the bottom of the watercourse with some concrete protection.

Distribution pipelines are almost exclusively installed underground, which further increases the level of operating safety.

7.2 Layout development principles

7.2.1 System layout

The future gas distribution systems will be supplied from the PRMS's, which are planned near the centres of large consumption areas of Kosovo. PRMS's are either planned as future additions to MKD-KOS gas interconnection above ground facilities such as block valve stations (BVS), as provided in the ongoing *North Macedonia – Kosovo gas interconnection FS* [5], or additions to above ground facilities on the planned transmission pipelines (gas ring and other transmission branches). The provisional transmission system layout including all planned PRMS facilities is presented in **Figure 32**.

The number and locations of the PRMS's satisfy the technical requirements for providing gas to the settlements/towns with the consumption potential.

The layout of the distribution pipelines is designed with the focus to supply major consumers such as industrial consumers, larger public/service facilities, and large market centres, while the pipelines continue to reach other consumers afterwards. The distribution systems can be either capillary or ring shaped. Distribution gas networks are further designed to enable network construction in individual settlements and districts, so it is possible to separate the parts of the network using closing valves.

The layout of the HP distribution system is designed to reach larger industrial consumers requiring working pressure higher than the operating pressure an MP gas network can provide. In addition, the HP distribution system is used in city outskirts where the pressure of the MP gas network is not satisfactory.

The construction of the MP gas distribution system allows for full gasification of peripheral parts of the selected towns and villages in the future by ensuring a satisfactory level of system pressure. Industrial zones are also supplied from the MP system to ensure the supply of sufficient quantities of gas and a satisfactory pressure level required for the operation of equipment installed at major consumers.

LP gas network is supplied with gas from a PRMS which is located at the MP distribution network. They measure gas quantities and reduce the pressure to the LP gas network operating pressure.

7.2.2 Consumer connections

Consumer connection starts at the connection point to the street pipeline.

In an LP gas network, the connection ends either with an external main isolation valve and a built-in facade cabinet (meter and pressure regulator) or a basement connection isolation valve located immediately upon connection entering the basement.

LP gas networks can be provided in old city centres and inner parts of towns when the dominating building structure (such as townhouses) prevents the gasification with medium pressure because of the specific installation of façade cabinets. The cabinets could come in the immediate vicinity of the pavement and the edge of the public road surfaces and could be in immediate danger of damage. In addition, culture-protective requirements could prevent the installation of façade cabinets.

For the MP gas network, the consumer connection ends with the external main isolation valve and a surface-mounted facade cabinet with a pressure reducer.

7.3 Potential gas distribution networks

To optimize the reach of gas system development a technical assessment of gas distribution networks in suitable settlements was performed.

To estimate the cost of the distribution systems the distribution pipelines length in the distribution system is necessary. The process of identifying potential natural gas distribution areas considered more densely populated parts of municipalities as the development of a gas network is generally not cost-effective in remote, less populated villages. For selected parts of the municipality, a presumption of 100% coverage[24] was made, i.e. connection to the network was provided to each household or other consumer (services, industry), by placing the network in every street, toward each potential consumer. Distribution systems were developed by hand using Google Earth software, Open Street View, relevant topographic maps and other available documents. For these planned distribution networks, the total length of the network per municipality was calculated. Provisional network layouts in assessed distribution areas are provided in **Annex 3[25].**

[24] Settlement coverage in reality is rarely 100%, however due to expected growth of urban parts of settlements (where gasification is envisaged), gas network would be expanded beyond current urban settlements, thus, an estimate of 100% of todays size of urban settlements is reasonable.

[25] Figures provided in Annex 3 are for illustrative purpose only. These distribution network layouts have been created with the sole purpose of estimating the potential length of the distribution network and should not be used for other purposes.

7.4 Preliminary distribution networks CAPEX and OPEX estimates

Previous technical analysis was carried out in order to calculate the required capital investment for each distribution area. From the technical point of view, the preliminary unit cost for a gas distribution networks is defined as an average price of 90 €/m'.

Capital investment costs (CAPEX) are provided in **Table 22** based on the total length of each developed network, the average unit price per meter of the pipeline, and the cost of the required facility on the distribution system which typically is the pressure reduction and metering station (PRMS) including odorising station (OS).

TABLE 22 – CAPEX FOR ALL INITIALLY DEVELOPED DISTRIBUTION NETWORKS

Municipality	District	Length of Distribution network (km)	CAPEX for MRS (€)	CAPEX for Distribution network (€)	Total (€)	Total (mil €)
Prishtina	Prishtina	942	2.000.000	84.780.000	86.780.000	**86,780**
Fushë Kosovë	Prishtina		included above			**0,000**
Obiliq	Prishtina		included above			**0,000**
Prizren	Prizren	302	1.000.000	27.180.000	28.180.000	**28,180**
Ferizaj	Ferizaj	286	1.000.000	25.740.000	26.740.000	**26,740**
Pejë	Peja	157	600.000	14.130.000	14.730.000	**14,730**
Gjakovë	Gjakova	140	600.000	12.600.000	13.200.000	**13,200**
Gjilan	Gjilan	247	600.000	22.230.000	22.830.000	**22,830**
Podujevë	Prishtina	111	600.000	9.990.000	10.590.000	**10,590**
Mitrovicë	Mitrovica	258	600.000	23.250.000	23.850.000	**23,850**
Mitr. e Veriut	Mitrovica	52	0	4.650.000	4.650.000	**4,650**
Vushtrri	Mitrovica	113	600.000	10.170.000	10.770.000	**10,770**
Suharekë	Prizren	32	500.000	2.880.000	3.380.000	**3,380**
Gllogoc (Drenas)	Prishtina	46	500.000	4.140.000	4.640.000	**4,640**
Lipjan	Prishtina	104	500.000	4.680.000	5.180.000	**5,180**
Rahovec	Gjakova	66	500.000	5.940.000	6.440.000	**6,440**
Malishevë	Prizren	30	500.000	2.700.000	3.200.000	**3,200**
Skenderaj	Mitrovica	33	500.000	2.970.000	3.470.000	**3,470**
Viti	Gjilan	101	500.000	3.030.000	3.530.000	**3,530**
Deçan	Gjakova	35	500.000	3.150.000	3.650.000	**3,650**
Istog	Peja	29	500.000	2.610.000	3.110.000	**3,110**
Klinë	Peja	43	500.000	3.870.000	4.370.000	**4,370**
Kamenicë	Gjilan	82	500.000	7.380.000	7.880.000	**7,880**
Dragash	Prizren	21	500.000	1.890.000	2.390.000	**2,390**
Kaçanik	Ferizaj	32	500.000	2.880.000	3.380.000	**3,380**
Shtime	Ferizaj	50	500.000	4.500.000	5.000.000	**5,000**
Hani i Elezit	Ferizaj	21	0	1.890.000	1.890.000	**1,890**
Mamushë	Prizren	16	500.000	1.440.000	1.940.000	**1,940**
Total			15.100.000	290.670.000	305.770.000	**305,770**

8 ECONOMIC EVALUATION AND SYSTEM DEVELOPMENT OPTIONS

8.1 Introduction

In this chapter, we describe the methodology, the inputs, and the results of the economic assessment of the future gas transmission and distribution network in Kosovo. The gas demand and supply analysis resulted in the preliminary layout of the Kosovo gas transmission network, shown in **Figure 32**. The figure shows two main components of the future gas transmission network: the **SKOPRI pipeline** (blue) and the **Ring pipeline** (red). Municipalities (consumption points) where gas supply was envisaged are shown as yellow dots. There are in total 28 municipalities (consumption points) for which gas demand was provided. In addition, magenta lines show pipelines required to connect some distribution areas to the main transmission network.

Regarding the structure of gas demand, the following customer categories were assumed:

Household sector

Services sector

Industry sector

Power generation sector.

The Consultant developed gas demand estimates for each of these sectors: details are presented in Chapter **4**. For all sectors, except for power generation, it was assumed gas will be introduced in 2026, while the power plant is expected to start operation in 2028. Regarding the power plant, it was assumed a new combined cycle gas turbine power plant is located in Prishtina municipality. **Figure 34** and **Figure 35** show absolute and relative shares of power and non-power generation sectors in total gas demand.

FIGURE 34 – ABSOLUTE SHARE OF GAS CONSUMPTION IN THE POWER SECTOR AND NON-POWER SECTOR

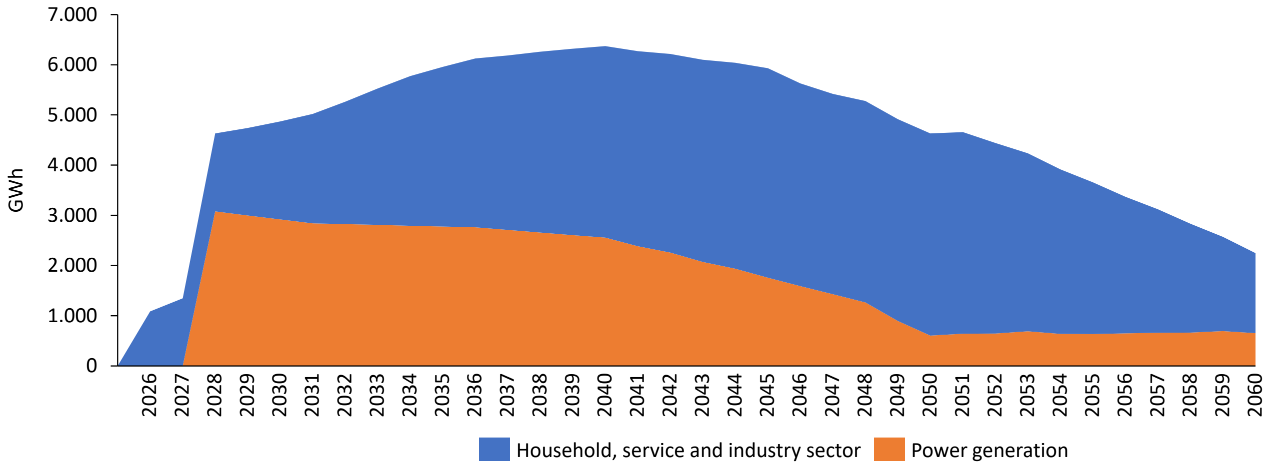
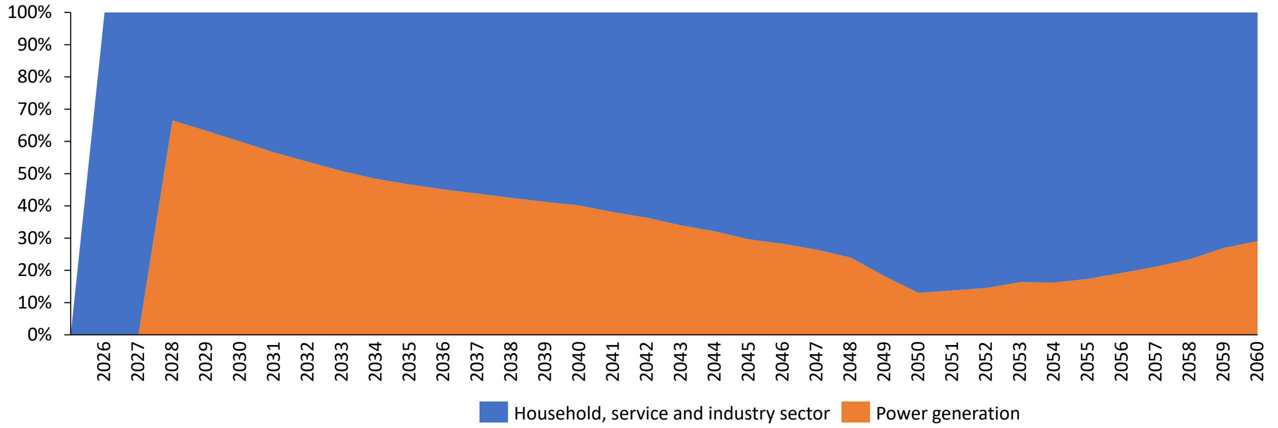
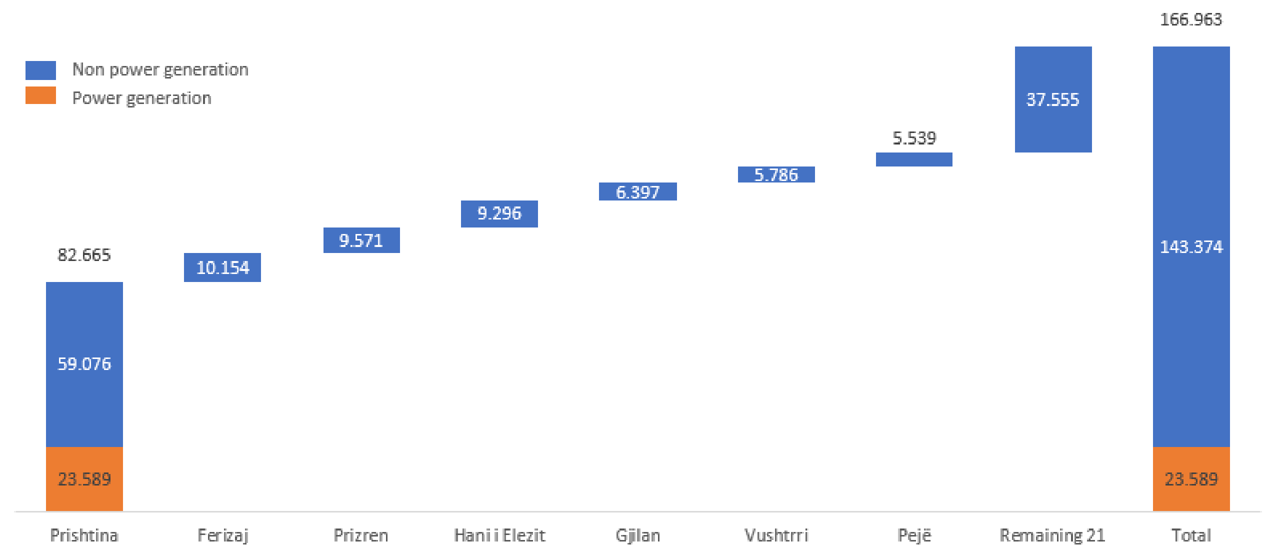


FIGURE 35 – RELATIVE SHARE OF GAS CONSUMPTION IN THE POWER SECTOR AND NON-POWER SECTOR



To determine where it will be feasible to develop the gas network, it is important to understand how much gas is expected to be consumed in each municipality. **Figure 36** shows most of the gas consumption occurs in a handful of municipalities. Out of 28 municipalities, seven municipalities constitute 78% of all gas consumption (including power generation gas consumption in Prishtina bar). Also see **Figure 14** for spatial distribution of demand.

FIGURE 36 – CUMULATIVE GAS DEMAND BY MUNICIPALITY DURING THE LIFE OF THE PROJECT (GWH)



8.2 Methodology

The principal assumption underpinning the economic evaluation of gas infrastructure in Kosovo is that gas transmission and distribution will be **regulated activities**. As discussed in the Tariff Study, the Consultant assumes that the **revenue cap** approach will be used to determine the allowed revenues for gas distribution and transmission. The goal of the analysis is to determine average gas distribution and transport tariffs in Kosovo and to assess the competitiveness of gas transmission and distribution tariffs[26].

The costs of gas distribution and transmission are driven primarily by two factors: the quantity of gas distributed or transported, and the costs associated with gas distribution and transport. Holding everything else constant, the higher the quantities of gas distributed and transported, the lower the gas tariffs, and vice-

[26] *In this section tariffs represent average gas tariffs for the duration of the entire project.*

versa. At the same time and holding everything else constant, the higher the costs associated with the gas distribution and transport (operating and capital costs combined) the higher the gas tariffs and vice versa. In summary, the level of gas tariffs is positively correlated with costs of gas distribution and transport and negatively correlated with the volume of gas distributed and transported. Furthermore, to assess whether it is economically feasible to supply a particular municipality with gas, one needs to determine the gas transmission and distribution costs separately.

To determine the gas distribution and transport costs, the Consultant used the following approach:

Distribution tariffs for each municipality were determined. The purpose of this analysis was to assess whether there is a sufficient gas demand in each municipality to justify the investment costs in developing the gas distribution network (**Step 1**).

Given that some municipalities are located away from the main transmission network, additional costs need to be incurred to connect these municipalities to the gas transmission network (costs related to pipelines marked in magenta in **Figure 32**). These costs were included in the costs for the development of the gas distribution network. The results of this analysis render some distribution areas not economically viable as they are located far away from the transmission network which results in a significant increase in capital expenditures. The result of this analysis is a selection of the municipalities that have competitive gas distribution tariffs. Following this step, the gas demand estimate is revised downward. Based on this gas demand the Consultant determines the viability of the gas transmission network (**Step 2**). The first two steps refer to the determination of the list of municipalities that are expected to have competitive gas distribution tariffs.

Analysis of the costs of gas transport is carried out using marginal cost analysis for SKOPRI and Ring pipelines. Marginal cost analysis implies that gas consumption that is located on a particular segment of the transport network has to cover the cost of development of that segment of the gas transport network. For example, consumers that are located on the SKOPRI pipeline must cover the costs of developing the SKOPRI pipeline. At the same time, consumers on the Ring pipeline are assumed to cover the costs of the development of the Ring pipeline only. Given that the SKOPRI pipeline is the backbone of the Kosovo gas transmission network, and that the Ring pipeline is an extension of the SKOPRI pipeline, in the marginal costs analysis, it is assumed that consumers on the Ring pipeline will pay for the use of the Ring pipeline only. The costs of the SKOPRI pipeline will be covered by SKOPRI users. While such an arrangement is not going to prevail in practice, it allows one to determine the incremental costs of developing the Ring pipeline and to compare tariffs on the Ring to tariffs on the SKOPRI pipeline. In addition to calculating the marginal gas transmission tariffs for the SKOPRI and the Ring pipeline separately, the Consultant also calculated the average gas transmission tariff that would prevail on the entire gas transmission network in Kosovo (SKOPRI + RING) **(Step 3)**.

8.2.1 Gas distribution tariffs

To determine the gas distribution tariffs, the Consultant carried out an analysis of 25 potential distribution areas[27]. Distribution system investment costs are assessed for each identified distribution area. The investment costs consist of:

Pipeline costs that are assumed to be identical for all municipalities and equal to 90 € per meter of pipelines.

Cost of measuring and reduction stations (MRS), except for Hani and Elezit municipality where the cost is included in the cost of the transmission network.

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*[27] Note that Chapter **7.3** identifies 28 potential distribution areas. However, due to proximity, the Consultant merged municipalities Obiliq and Fushë together with Prishtina. Furthermore, municipality Vushtrri has been considered together with Mitrovicë as Vushtrri has an acceptable level of distribution tariff that cannot be completed without section to Mitrovicë. These mergings resulted in 25 distribution areas for analysis.*

Operating costs are estimated at 2% per annum of total investment costs.

Summary of the investment costs in the distribution network are presented in **Table 22** in the previous chapter.

In the process of determining the gas distribution tariffs, the Consultant made the following assumptions:

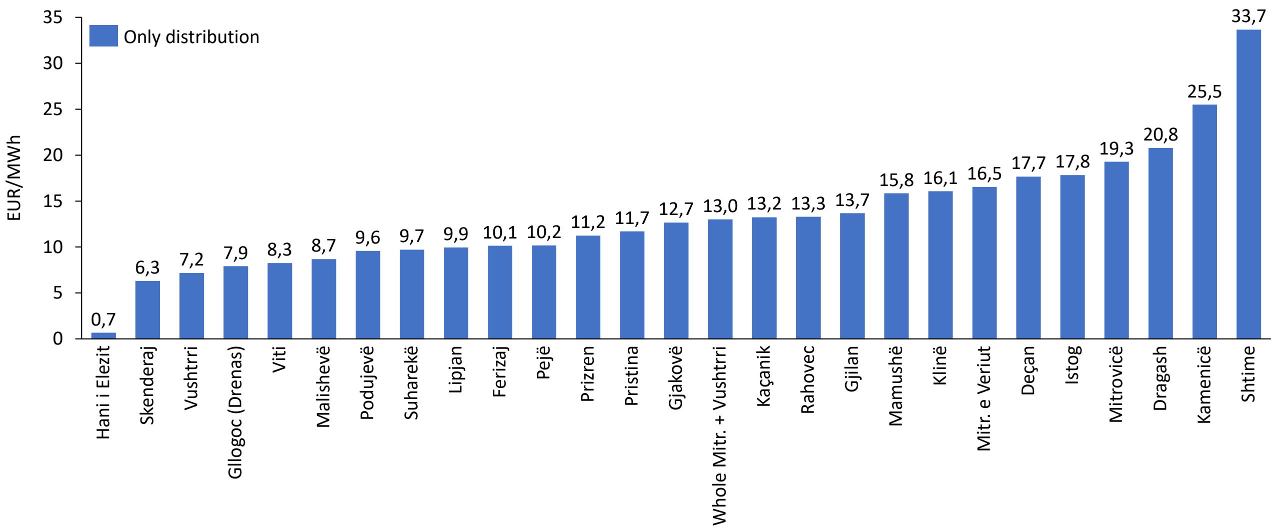
Given that the energy regulatory office of Kosovo (ERO) has not published the weighted average cost of capital for gas distribution and transmission activities, the Consultant used a value that is implemented for electricity transmission and distribution activity. In particular, the Consultant assumed the value for **real** weighted average costs of capital in the amount of 8,3% p.a., according to the ERO decision. V_1018_2018.

Given that the demand is expected to grow over time, it is assumed that the gas distribution network is gradually built over 5 years.

Development of the distribution networks will start concurrently in all distribution areas, i.e., construction of distribution networks will start in 2025 and end in 2031 in all municipalities.

Based on the above assumptions, **Figure 37** provides values of distribution tariffs for analysed municipalities. These tariffs represent the values corresponding to the development of the distribution network only (step 1). Note that distribution area Whole Mitrovica + Vushtrri consists of Vushtrri and both Mitrovicë: Mitrovicë and Mitr. e Veriut.

FIGURE 37 – ESTIMATE OF DISTRIBUTION TARIFFS



As **Figure 32** shows, some distribution areas are located away from the main transmission pipeline (both from SKOPRI and Ring). It is assumed that costs related to connecting these gas distribution networks to the gas transmission network should be added to their distribution development costs. Therefore, for the following distribution areas additional pipeline costs related to the connection to the gas transmission network were added to the costs of development of distribution networks:

On the Skopje-Prishtina gas transmission pipeline (pipeline marked in blue on **Figure 32**):

Hani i Elezit: 2,7-kilometer segment from BVS Hani i Elezit to PRMS Hani i Elezit (Sharrcem)

Kaçanik: 4-kilometre segment from BVS Kaçanik to PRMS Kaçanik

Gjilan: 24,9-kilometre segment from TTS/RMS Ferizaj to PRMS Gjilan

Kamenicë: 26-kilometre segment from PRMS Gjilan to PRMS Kamenicë

Shtime: 16,7-kilomenter segment from PTS/PRMS Ferizaj to PRMS Shtime

Podujevë: 33-kilomenter regement from PRMS Prishtina 2 to PRMS Podujevë

On the Kosovo ring pipeline (pipeline marked in red on **Figure 32**):

Mitrovicë: 16,5-kilometre segment from PTS/PRMS Skenderaj to PRMS Mitrovica

Vushtrri: 7,2-kilometre segment from PRMS Mitrovica to PRMS Vushtrri

Klinë: 25-kilometre segment from PTS/PRMS Peja to PRMS Klina

Rahovec: 8-kilometer segment from BVS Krushë e Medhe to PRMS Rahovec

Malishevë: 12-kilometer segment from PRMS Rahovec to PRMS Malishevë

Mamushë: 8-kilometer segment from PRMS Suhareka to PRMS Mamushë

Dragash: 26-kilometer segment from PTS/PRMS Prizren to PRMS Dargash

Table 23 shows the structure of costs for developing the gas distribution network. It includes the costs of developing only the distribution network in each municipality together with the cost and length of the segment required to connect the distribution network of a municipality to the transmission network.

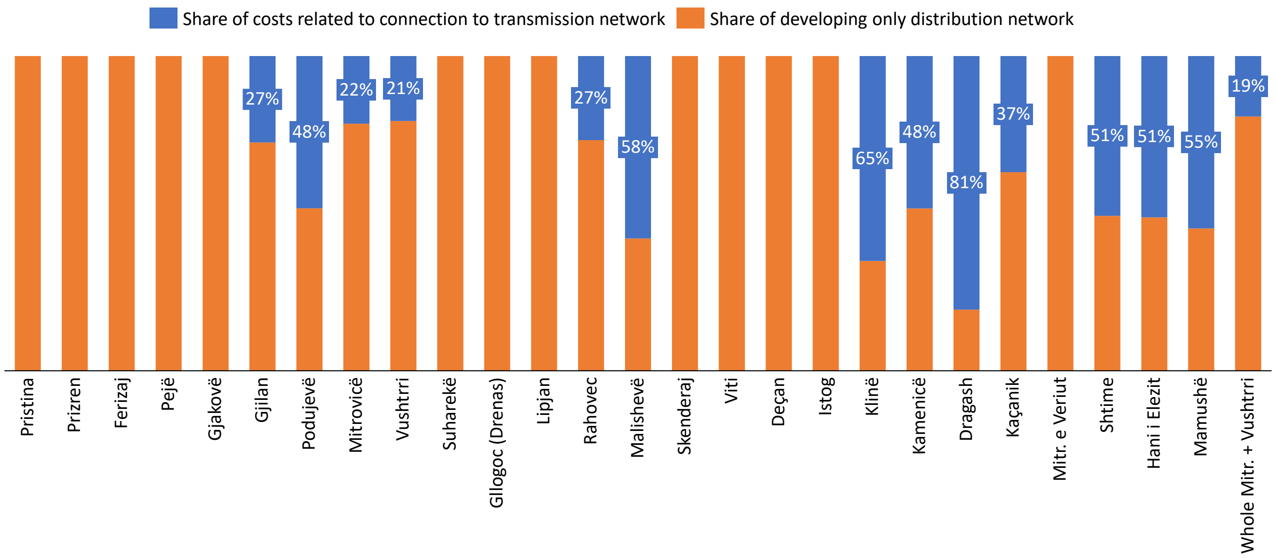
TABLE 23 – TOTAL COST OF DEVELOPING DISTRIBUTION NETWORK

No.	Municipality	District	The total cost of developing the distribution network			
			Distribution	Connection to transmission		Total costs
			Costs [mln €]	Length [km]	Costs [mln €]	Costs [mln €]
1	Prishtina	Prishtina	86,78	-	-	86,78
2	Prizren	Prizren	28,18	-	-	28,18
3	Ferizaj	Ferizaj	26,74	-	-	26,74
4	Pejë	Peja	14,73	-	-	14,73
5	Gjakovë	Gjakova	13,20	-	-	13,20
6	Gjilan	Gjilan	22,83	24,90	8,65	31,48
7	Podujevë	Prishtina	10,59	33,00	9,93	20,52
8	Mitrovicë	Mitrovica	23,85	16,50	6,55	30,40
9	Vushtrri	Mitrovica	10,77	7,20	2,81	13,58
10	Suharekë	Prizren	3,38	-	-	3,38
11	Gllogoc (Feronikal)	Prishtina	4,64	-	-	4,64
12	Lipjan	Prishtina	5,18	-	-	5,18
13	Rahovec	Gjakova	6,44	8,00	2,35	8,79
14	Malishevë	Prizren	3,20	12,00	4,42	7,62
15	Skenderaj	Mitrovica	3,47	-	-	3,47
16	Viti (Smire)	Gjilan	3,53	-	-	3,53
17	Deçan	Gjakova	3,65	-	-	3,65
18	Istog	Peja	3,11	-	-	3,11
19	Klinë	Peja	4,37	25,00	8,16	12,53

20	Kamenicë	Gjilan	7,88	26,00	7,41	15,29
22	Dragash	Prizren	2,39	26,00	9,92	12,31
23	Kaçanik	Ferizaj	3,38	4,00	1,98	5,36
24	Mitr. e Veriut	Mitrovica	4,65	-	-	4,65
25	Shtime	Ferizaj	5,00	16,70	5,16	10,16
27	Hani i Elezit	Ferizaj	1,89	2,70	1,99	3,88
28	Mamushë	Prizren	1,94	8,00	2,35	4,29
Total			**305,77**	**210**	**71,69**	**377,46**

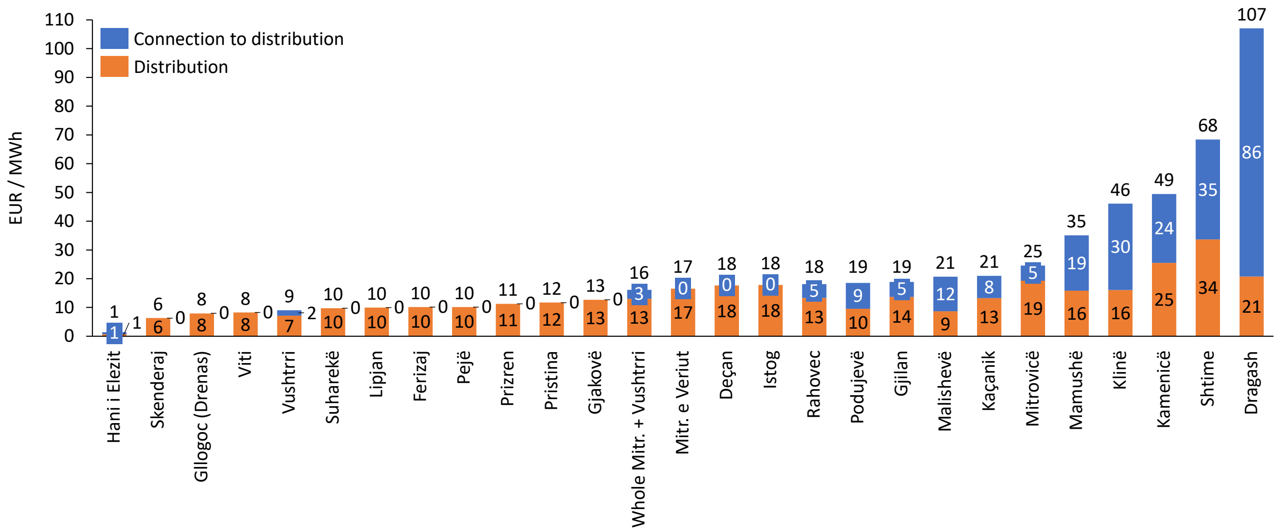
Figure 38 shows the structure of costs of developing the gas distribution network. The figure shows that for some municipalities, the share of costs related to the connection to the gas transmission network represents a significant component of the total distribution network development costs. Also, as was the case in **Figure 37**, in this figure costs of both Mitrovica and Vushtrri were combined to represent a single distribution area (indicated as Whole Mitr. + Vushtri in **Figure 38**). In addition, both Mitrovica were combined (Mitrovicë and Mitr. e Veriut).

FIGURE 38 – STRUCTURE OF INVESTMENT IN DISTRIBUTION NETWORK



Based on the above analysis, the total unit cost of developing a gas distribution networks is calculated and shown in **Figure 39**. As **Figure 39** shows, a large distance from the main transmission networks significantly increases per MWh costs ("distribution tariff") of gas distribution network.

FIGURE 39 – ESTIMATE OF TOTAL DISTRIBUTION TARIFFS



To determine the distribution areas where it is economically feasible to develop a gas distribution network, it was necessary to define whether the prevailing average gas distribution tariffs are cost-competitive. To assess the cost competitiveness of future gas distribution tariffs in Kosovo, the Consultant compared the calculated distribution tariff values to the prevailing gas distribution tariffs in Croatia. Croatia was chosen for the following reasons:

Gas distribution is an activity that is conducted separately from the gas transmission, and retail. In other words, gas distribution prices (tariffs) are clearly defined and transparent.

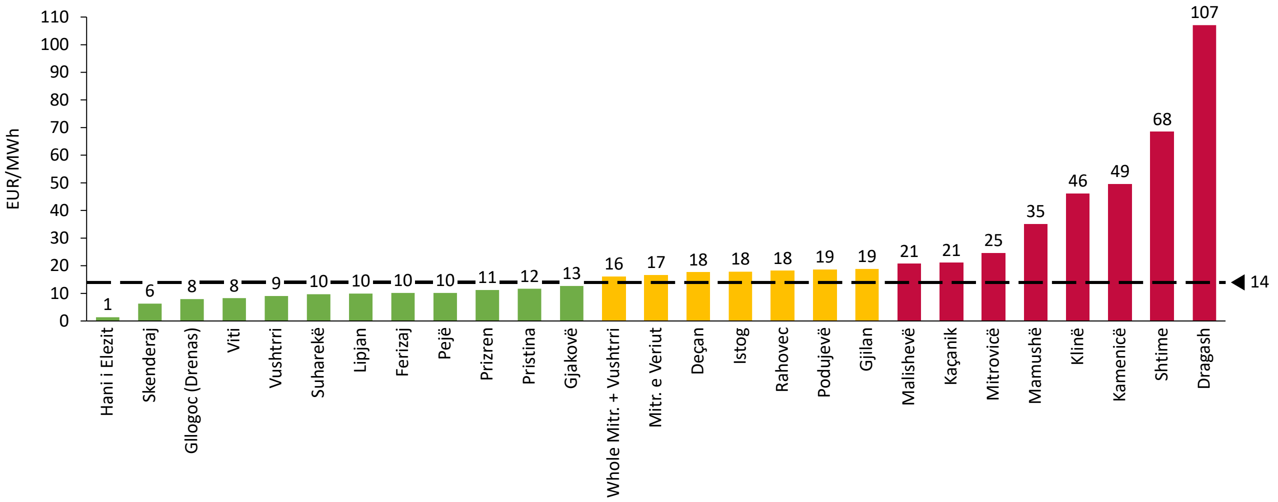
A gas distribution network has been developed over a long period. This implies there are gas distribution networks (areas) that are in operation for several decades (continental part of the country) but also distribution networks that were developed during the last decade (mainly coastal sections of the country).

The weighted average gas distribution tariff for all distribution areas in Croatia in 2020 was 6,68 €/MWh, ranging from 4 €/MWh to 13,3 €/MWh[28]. Therefore, in the preliminary analysis, the Consultant assumed only those distribution areas with effective gas distribution tariff (which includes connection to the gas transmission network) of 14 €/MWh or less would be economically feasible. As a result, the following 11 distribution areas have an acceptable level of gas distribution tariffs, i.e. below 14 €/MWh: Prishtina, Prizren, Ferizaj, Pejë, Gjakovë, Vushtrri, Suharekë, Drenas , Lipjan, Skenderaj, Viti, Hani i Elezit.

Moreover, six additional municipalities had tariffs between 14 €/MWh and 20€/MWh. While these tariffs were above the predefined threshold, the Consultant included these municipalities as potential gas demand centers. The rationale for including these municipalities is that their distribution tariff, while being above the predefined threshold of 14 €/MWh, is still not excessively high and Kosovar authorities might still decide to develop gas distribution network in those municipalities (either via pipeline gas or LNG/CNG) These six gas demand centers include municipalities: Gjilan, Podujevë, Rahovec, Deçan, Istog, Mitr. e Veriut and Whole Mitrirovica plus Vushtrri. This last consumption center was created by combining the whole of Mitrovica with Vushtrri municipality. While Vushtrri municipality had an acceptable level of gas distribution tariffs (9 €/MWh), Mitrovica did not (25 €/MWh), while Mitr. e Veriut did (17 €/MWh). On the other hand, when these two municipalities were taken together, their combined gas transmission tariff was above 14 €/MWh but still below 20 €/MWh (16,2 €/MWh). **Figure 40** provides the list of feasible gas distribution areas in green. The following distribution areas represent over 90% of non-power sector demand. This concludes the analysis outlined in Step 2.

[28] *Source: Croatian Energy Regulatory Agency, Annual report, 2020 available at https://www.hera.hr/hr/docs/HERA_izvjesce_2020.pdf*

FIGURE 40 – ESTIMATE OF TOTAL DISTRIBUTION TARIFFS

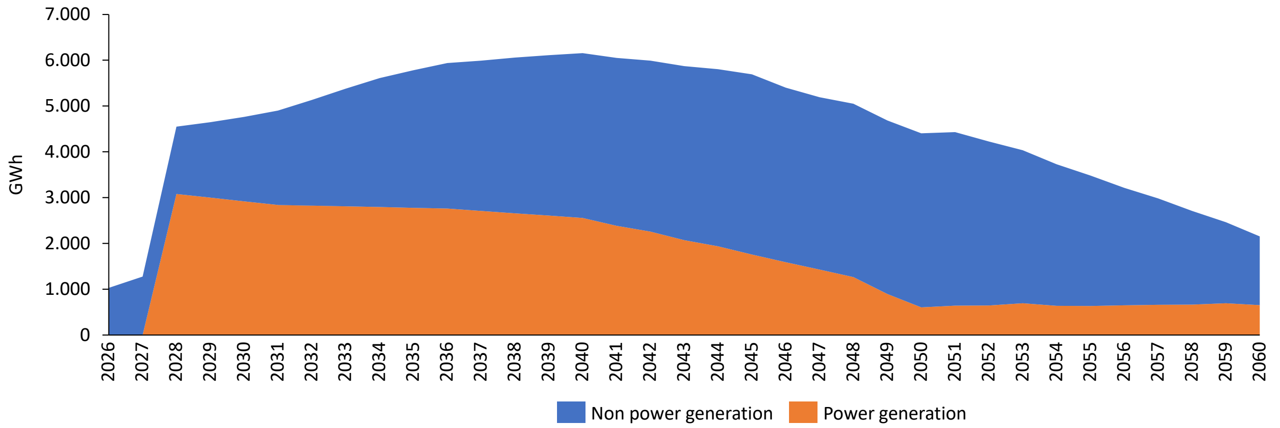


To summarize, the necessary layout of the gas transmission system to enable the gasification of the distribution areas for which the Consultant determined acceptable levels of gas distribution tariffs (green and yellow) are given in the following figure.

FIGURE 41 – DISTRIBUTION AREAS WITH COMPETITIVE GAS DISTRIBUTION TARIFFS

Based on the above analysis of the feasible and borderline distribution areas (green and yellow as in **Figure 40**) and gas demand projections for power generation, **Figure 42** provides feasible gas demand for the gas sector in Kosovo. As the figure shows, power generation represents a significant share of gas demand which slowly declines due to transformation of Kosovo energy sector.

FIGURE 42 – FEASIBLE GAS DEMAND

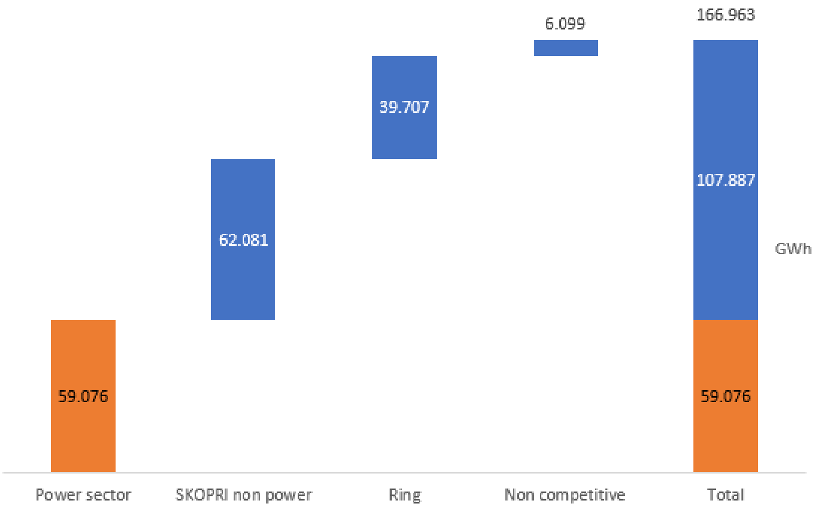


8.2.2 Transmission tariffs

The planned transmission network in Kosovo consists of two segments: SKOPRI and Ring. SKOPRI pipeline represents the construction of the pipeline from the Kosovo border to Prishtina (marked in blue), while the Ring pipeline represents the development of the loop gas network (marked in red), depicted in **Figure 32**. In this chapter, we calculate the gas transmission tariffs for 1) SKOPRI segment, 2) Ring segment, and 3) combined SKOPRI and Ring segment. The purpose of such an analysis is to determine the marginal cost of developing each gas transmission pipeline segment.

To carry out the analysis, the Consultant determined the allowed revenue that would prevail under the development of each segment. Based on the allowed revenue and the forecasted gas transmission volumes, the Consultant calculated an average tariff assuming the revenue cap regulatory approach is used, as indicated in the chapter on the methodology. Regarding the gas volumes used in the calculation of gas transmission tariffs, note that in the chapter on gas distribution tariffs some municipalities for which potential gas demand was calculated were considered to have non-competitive gas distribution tariffs, and were hence excluded. **Figure 43** shows the shares of gas consumption for SKOPRI non-power sector, power sector, Ring section, and municipalities that were deemed to have non-competitive gas distribution tariffs, and whose gas demand was not taken into consideration when determining the average gas transmission tariffs for the whole duration of the project (years 2026-2060). In terms of the dynamics of the development of the gas transmission network, it is assumed that the transmission network would be operational in 2026.

FIGURE 43 – CUMULATIVE GAS QUANTITIES USED IN CALCULATION OF AVERAGE TRANSMISSION TARIFFS DURING THE LIFETIME OF THE PROJECT



Once the tariffs for three distinctive options (only SKOPRI segment, only RING segment, and combined RING and SKOPRI segment) are calculated, it is necessary to assess their competitiveness. In **Table 24** we report average gas transmission tariffs for selected European countries. These tariffs are calculated in the same manner as the average tariffs for different transmission pipeline network segments in Kosovo. For each of these European countries official data on the allowed revenue was collected with the amount of gas transported through the gas transmission pipeline. The average gas transmission pipeline tariff was calculated as the ratio of allowed revenue and quantity of gas transported through the gas transmission pipeline.

In the following three subchapters we provide the results of the calculations of gas transmission tariffs for SKOPRI, Ring, and the combined SKOPRI and Ring pipeline. A separate analysis of SKOPRI and Ring pipeline allows one to assess the contribution to the overall gas transmission tariffs of each transmission pipeline segment and to shed light on the possible dynamics of the development of the gas transmission network.

TABLE 24 – AVERAGE TARIFFS IN SELECTED EUROPEAN COUNTRIES

Country	Company	Year	Allowed revenue [mln €]	Gas volume [GWh]	Average tariff [€/MWh]
[1]	[2]	[3]	[4]	[5]	[6]= [4]/ [5]
Croatia	Plinacro ltd.	2021	54,5	32.481	1,68
Slovenia	Plinovodi d.o.o.	2020	34,7	16.783	2,07
Hungary	FGSZ	10/2019-9/2020	186	180.790	1,03
Romania	SNTGN Transgaz SA	10/2019-9/2020	255,7	133.613	1,91
Greece	DESFA	2020	101,1	67.370	1,50
N. Macedonia	GAMA AD	2022	6,50	2.252	2,89

Source: ACER, N. Macedonian regulatory agency

8.2.2.1 Gas transmission tariffs for the development of the SKOPRI pipeline

Gas transmission pipeline SKOPRI assumes investments of 72,3 million € (see **Table 21**) for the Kosovo section. The SKOPRI pipeline would provide natural gas to the gas power plant located in Prishtina and to the following distribution areas: Hani i Elezit, Viti (Smire), Ferizaj, Gjilan, Lipjan, Prishtina (includes Prishtina, Fushë Kosovë and Obiliq), and Podujevë.

The prevailing gas transmission tariff for the SKOPRI pipeline is 2,16 €/MWh[29]. Compared to gas transmission tariffs in the region (shown in **Table 24**), this is a relatively competitive tariff. Nevertheless, what should be stressed is that in the absence of the gas power plant, the resulting tariff would be significantly higher and would amount to 5 €/MWh.

8.2.2.2 Gas transmission tariff for the development of Ring pipeline

The ring gas transmission pipeline has been budgeted at 93,5 (see **Table 21**) million €. Based on the optimization of the distribution areas, the following municipalities are expected to be connected to the Ring pipeline (green and yellow): Drenas (Feronikal), Skenderaj, Mitrovicë, Mitr. e Veriut, Vushtrri, Istog, Pejë, Deçan, Gjakovë, Rahovec, Suharekë, and Prizren.

The resulting gas transmission tariff for the Ring transmission pipeline is 10,3 €/MWh. It should be remembered that this tariff represents a marginal tariff. What this means is that this tariff would be charged to the users of the Ring pipeline only with the purpose to recover the costs of the development of the Ring pipeline. While

[29] *Taking into account DN600 SKOPRI sized for more broad gasification. Note that in case of no construction of gas ring, the gas quantities and required dimensions of SKOPRI pipeline would be lower further reducing the tariff.*

this scenario is unlikely to occur in real life situation, it allows one to assess the true cost of developing the Ring pipeline.

When compared to gas transmission tariffs in the neighbouring countries, this is an extremely high tariff level. The reason for this high gas transmission tariff level is relatively low forecasted consumption and high investment costs. For illustration, **Table 25** shows the comparison of specific investment cost for SKOPRI and for Ring separately.

TABLE 25 – COMPARISON OF INVESTMENT COSTS AND CUMULATIVE GAS DEMAND FOR SKOPRI AND RING PIPELINE

Section	Investment	Cum. gas demand	Investment intensity
	000 €	GWh	€/GWh demand
SKOPRI	72.278	121.157	597
Ring	93.544	39.707	2.356

8.2.2.3 Gas transmission tariffs for the development of the entire gas transmission network (SKOPRI and Ring combined).

If the Kosovo authorities decide to build the entire gas transmission network, it will consist of SKOPRI and Ring segments with the corresponding gas consumption areas as identified in the preceding two subchapters. The resulting gas transmission tariff for all municipalities would be 3,9 €/MWh. While this tariff is not entirely excessive, **Table 24** shows that such a tariff would be the highest among observed countries in the region.

8.2.2.4 Limited development of Ring pipeline

As the above analysis of the Ring pipeline has shown, the construction of the entire Ring pipeline almost doubles the transmission system tariff. Therefore, the Consultant analysed a limited expansion of the Ring pipeline. This implies that an analysis of the extension of the SKOPRI pipeline is carried out. Extension of the SKOPRI pipeline is conducted in two directions:

- Extension from the north of SKOPRI: the municipalities in the north of Kosovo are consecutively added as long as the feasibility criteria is fulfilled, i.e. Ring pipeline is developed starting from Prishtina towards Mitrovica, Istog, Gjakove, Prizren, and Suharekë.
- Extension from the south segment of SKOPRI: municipalities west of Ferizaj are consecutively added as long the feasibility criteria is fulfilled, i.e., Ring pipeline is developed starting from Ferizaj towards Prizren, Deçan, and Mitrovicë.

Table 26 provides overall average tariffs (for all users) resulting from the limited expansion of the SKOPRI pipeline. The table shows that the lowest overall gas transmission tariff is obtained when the SKOPRI pipeline is expanded to include Drenas (Ferronikeli). This tariff is even lower than the one for the SKOPRI pipeline. The additional extension might include Mitrovica and Vushtrri area: in this case, the tariff would still be lower than in the case of the SKOPRI pipeline. Any other extension of the Ring pipeline would increase the gas transmission tariffs.

TABLE 26 – OVERALL AVERAGE GAS TRANSMISSION TARIFFS FOR STAGED DEVELOPMENT OF KOSOVO GAS TRANSMISSION PIPELINE

	€/MWh			€/MWh
SKOPRI	2,16		SKOPRI	2,17
Drenas (Feronikal)	2,02		Suharekë	2,75
Skenderaj	2,24		Prizren	2,94
Mitrovica + Vushtri	2,10		Rahovec	3,14
Istog	2,39		Gjakovë	3,32
Peja	2,65		Decan	3,58
Decan	2,78		Peja	3,75
Gjakovë	2,99		Istog	4,08
Rahovec	3,14		Skenderaj	4,46
Prizren	3,29		Mitrovica + Vushtri	4,13
Suharekë	3,43		Gllogoc (Feronikal)	3,71

Note the difference between average overall tariff for the system with complete Ring (**8.2.2.3**) and the tariff for the system as given in **Table 26** results from missing closing section of the ring.

8.3 Gas transmission network costs

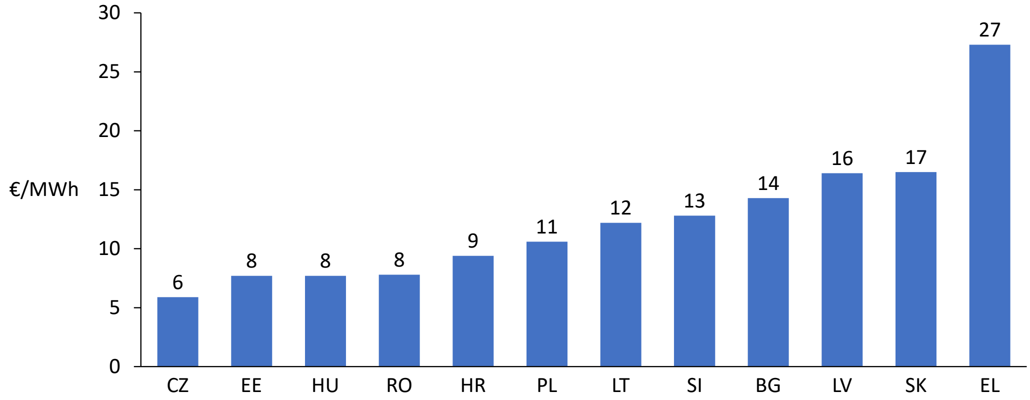
Total gas network costs for the supply of natural gas to the final consumers consist of gas transmission and distribution costs. Therefore, to gauge the competitiveness of the gas infrastructure, one needs to look at the total gas network costs, which consist of gas transmission and distribution costs. To be able to assess the competitiveness of gas network costs in Kosovo, the Consultant compares them to the gas network costs in selected European countries. **Figure 44** and **Figure 45** provide the values of total network costs for household and non-household consumers in selected European countries[30].

Figure 44 shows that the level of network costs for household consumers ranges between 8 €/MWh and 17 €/MWh, with Greece as an outlier with network cost of 27 €/MWh. **Figure 45** provides the same information for non-household consumers. It shows that the range of network costs for non-household consumers is between 3 €/MWh and 8 €/MWh. While the objective of the Gross domestic product Kosovo was not to determine the final pricing strategy for gas consumers, it is still possible to make the comparison to the data presented in the following two figures. For example, Hani I Elezit which is dominantly an industrial consumer, and which is located on the SKOPRI pipeline would face a total gas network costs of less than 4 €/MWh in case of development of SKOPRI pipeline only, or 5 €/MWh in case of the construction of the entire Ring.

Most of the other municipalities consist of household consumers, and **Figure 46** and **Figure 47** show their total gas network costs. It is clear that except for Podujevo and Giljan, all municipalities on SKPOPRI pipeline would have competitive gas network tariffs as they are all below 15 €/MWh (**Figure 46**). If both Ring and SKOPRI pipeline would be built, the resulting network costs for most of the Ring municipalities would be relatively high. **Figure 48** shows geographical distribution of total network costs for considered distribution areas.

[30] *Country abbreviations: Bulgaria-BG; Czechia-CZ; Estonia-EE; Greece-EL; Croatia-HR; Lithuania-LV;, Latvia-LT; Hungary-HU; Poland-PL; Romania-RO; Slovenia-SI; Slovakia-SK.*

FIGURE 44 – SELECTED EUROPEAN GAS NETWORK COSTS FOR HOUSEHOLD CONSUMERS



Source: EUROSTAT

FIGURE 45 – SELECTED EUROPEAN GAS NETWORK COSTS FOR NON-HOUSEHOLD CONSUMERS

Source: EUROSTAT

FIGURE 46 – GAS NETWORK COSTS FOR CONSUMPTION AREAS IF SKOPRI ONLY IS DEVELOPED

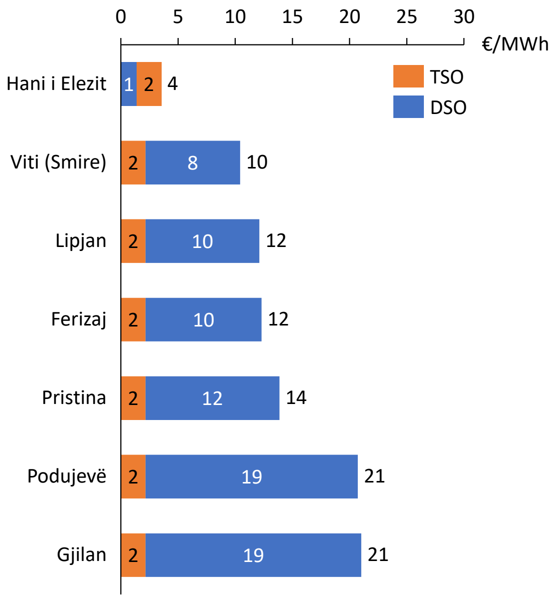


FIGURE 47 – GAS NETWORK COSTS FOR SELECTED CONSUMPTION AREAS IF SKOPRI AND RING ARE DEVELOPED

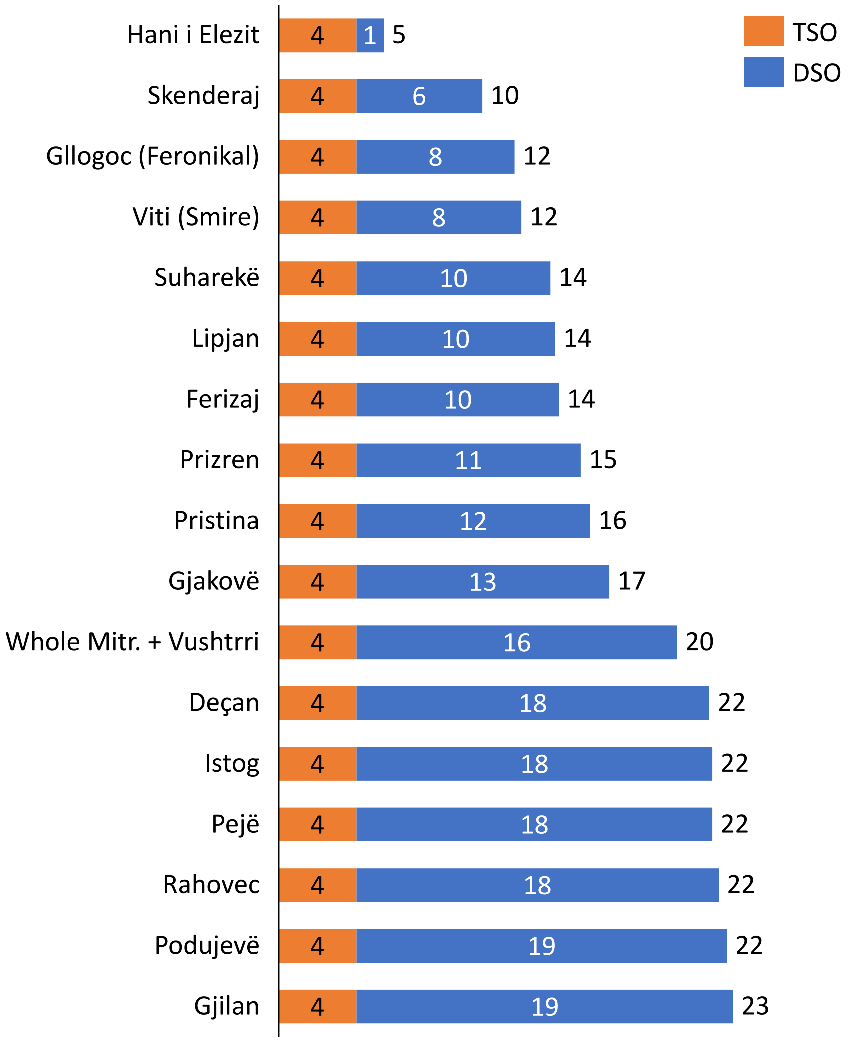
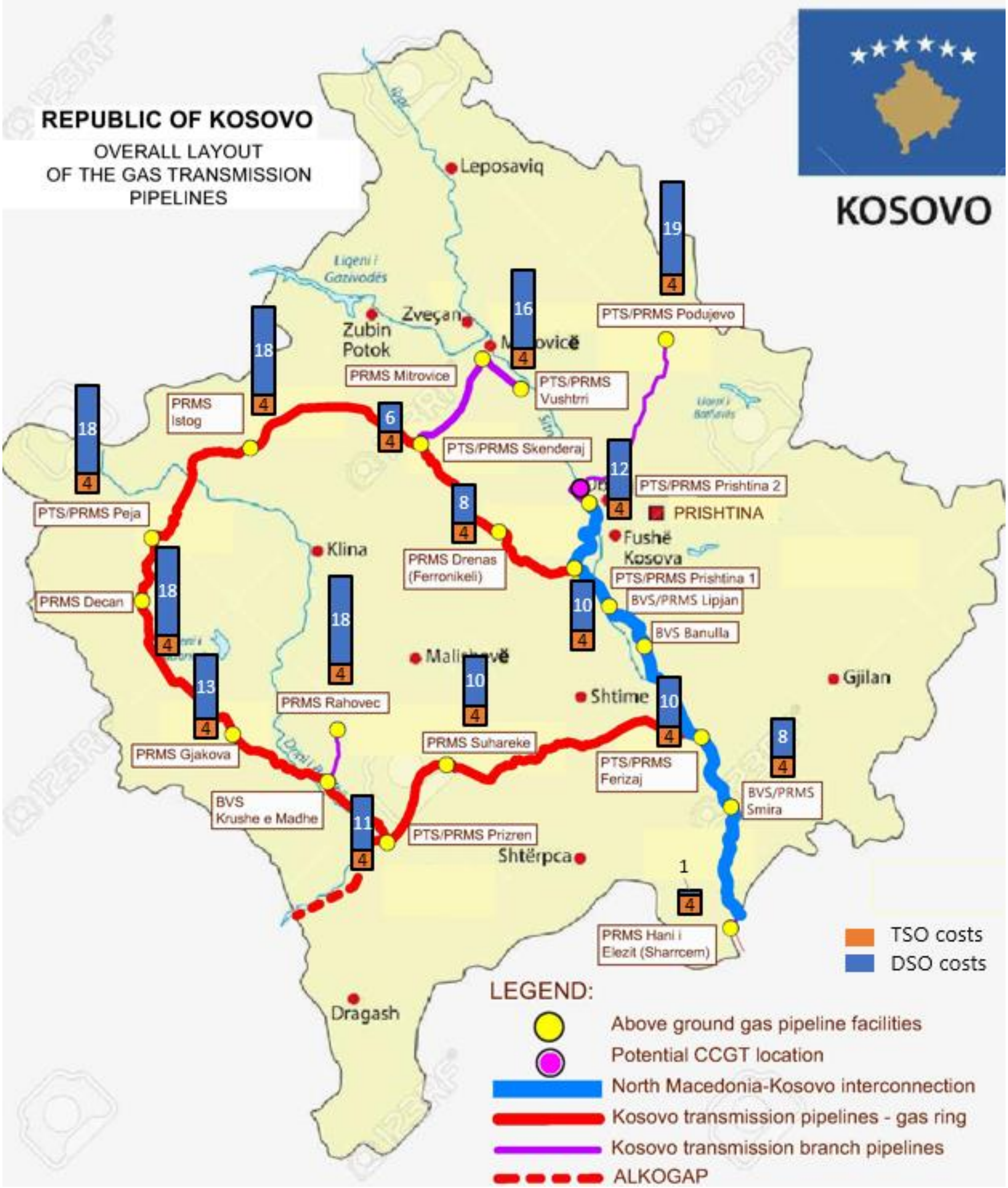


FIGURE 48 – GEOGRAPHICAL DISTRIBUTION OF GAS NETWORK COSTS FOR SELECTED CONSUMPTION AREAS IF SKOPRI AND RING ARE DEVELOPED



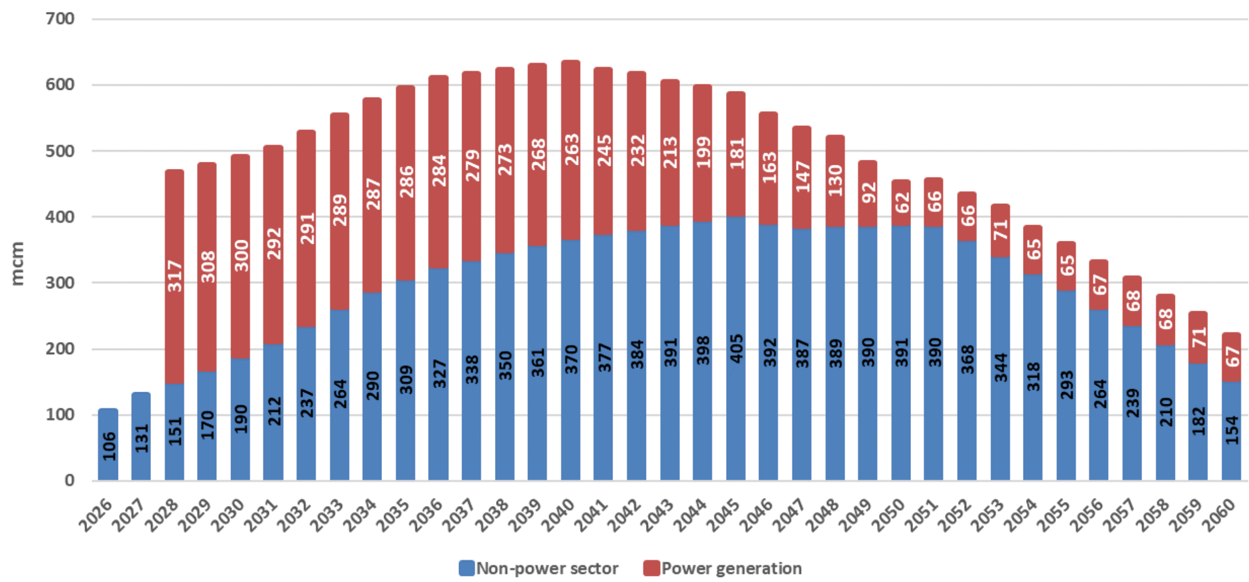
9 OPTIMIZED GASIFICATION SCENARIOS

9.1 Large gasification scenario

Large gasification scenario implies development of the SKOPRI and Ring pipeline together. In terms of the development areas, this scenario includes economically viable distribution areas as indicated in **Figure 48**; Hani I Elezit, Skenderaj, Drenas, Viti, Vushtrri, Mitrovica, Mitrovica e Veriut, Suharekë, Lipjan, Ferizaj, Pejë, Prizren, Prishtina (including Obiliq and Fushë Kosovë), Gjakovë, Deçan, Istog, Rahovec, Podujevë, and Gjilan.

The estimated peak hourly gas demand is 226 000 m^3/h (135 000 m^3/h for non-power sector and 91 000 m^3/h for power sector) and is reached in 2045. The peak annual gas demand of 633 mcm is reached in 2040 (370 mcm in non-power sector and 263 for power generation), as illustrated in **Figure 49**.

FIGURE 49 – GAS DEMAND IN LARGE GASIFICATION SCENARIO



9.1.1 Transmission system parameters

The respective hydraulic calculation resulted in a MKD-KOS interconnection diameter DN600 and required inlet pressure of 41 bar in Skopje; (41 bar required for DN 600 to get 30 in the planned CCGT near Prishtina). Resulting pipe and hydraulic parameters and respective CAPEX are provided in **Table 27**.

TABLE 27 – RESULTS OF HYDRAULIC CALCULATIONS AND CAPEX FOR TRANSMISSION PIPELINES DEVELOPED IN LARGE GASIFICATION SCENARIO

	No	Municipality	District	Section	Length (km)	Diam. (inch)	Pressure at the end of the section (barg)	Total (mil €)
MKD-KOS interconnection	0	Republic of North Macedonia		MKD Conection point - MKD/KOS Border	27,0	24	**37,94**	**N/A**
	1-1	Hani i Elezit	Ferizaj	MKD/KOS Border - BVS Hani i Elezit	0,4	24	**38,10**	
	1-2	Kacanik	Ferizaj	BVS Hani i Elezit - BVS Kacanik	7,5	24	**36,92**	
	1-3	Viti	Ferizaj	BVS Kacanik - Smire	9,8	24	**37,24**	**18,859**
	2	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	24	**36,25**	**13,212**
	3	Ferizaj	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	24		**13,671**
	4	Lipjan	Prishtina	PRMS Banulla - BVS/PRMS Lipjan	8,0	24	**35,06**	**7,672**
	5	Prishtina	Prishtina	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	24	**34,76**	**6,636**
	6	Obiliq	Prishtina	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	24	**34,55**	**12,228**
		SUBTOTAL MKD/KOS Interconnection (w/o MKD section):			**75,5**			**72,278**
Gas ring	7	Shtime	Ferizaj	PTS/PRMS Ferizaj - PRMS Suharekë	39,6	10	**33,30**	**19,623**
	8	Suharekë	Prizren	PRMS Suharekë - PTS/PRMS Prizren	15,3	10	**32,24**	**6,366**
	9	Prizren	Prizren	PTS/PRMS Prizren - BVS Krushe e Madhe	13,3	10	**32,23**	**6,369**
	10	Gjakovë	Gjakova	BVS Krushe e Madhe - PRMS Gjakova	15,5	10	**31,95**	**6,197**
	11	Deçan	Gjakova	PRMS Gjakova - PRMS Decan	24,0	10	**31,49**	**8,800**
	12	Pejë	Peja	PRMS Decan - PTS/PRMS Peja	12,0	10	**31,65**	**5,535**
	13	Istog	Peja	PTS/PRMS Peja - PRMS Istog	24,0	10	**31,95**	**10,995**
	14	Skenderaj	Mitrovica	PRMS Istog - PTS/PRMS Skenderaj	28,0	10	**31,76**	**12,598**
	15	Gllogoc	Prishtina	PRMS Drenas - PTS/PRMS Skenderaj	17,7	10	**31,76**	**8,675**
	16	Fushë Kosovë	Prishtina	PTS/PRMS Prishtina 1 - PRMS Drenas	14,7	10	**33,30**	**8,389**
		SUBTOTAL Gas ring:			**204,1**			**93,547**
Transmission branches	17	Mitrovicë	Mitrovica	PTS/PRMS Skenderaj - PRMS Mitrovica	16,5	6	**25,63**	**6,545**
	18	Vushtrri	Mitrovica	PRMS Mitrovica - PTS/PRMS Vushtrri	7,2	6	**25,00**	**2,808**
	19	Ferizaj	Ferizaj	PTS/PRMS Ferizaj - PTS/PRMS Gjilan	24,9	6	**33,51**	**8,653**
	20	Rahovec	Gjakova	BVS Krushe e Madhe - PRMS Rahovec	8,0	4	**31,28**	**2,352**
	21	Podujevë	Prishtina	PTS/PRMS Prishtina 2 - PTS/PRMS Podujevo	33,0	4	**20,30**	**9,927**
	22	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit (Sharrcem)	2,7	4	**37,50**	**1,989**
		SUBTOTAL Transmission branches (already in distribution costs, see Table 23):			**92,3**			**32,273**
TOTAL Kosovo Gas transmission system (w/o transmission branches):					279,6			165,83

Total distribution network CAPEX is estimated at 377,46 mln €, as provided in **Table 23**. Together with estimated 165,83 mln € of investments in the transmission network, the overall CAPEX in this scenario is 543 mln €.

9.1.2 Economic and tariff calculations

Large gasification scenario implies average gas transmission tariff of 3,9 €/MWh. Economic and tariff calculations for scenario have been described in more details in Section **8.2.2.3**. Gas distribution tariffs are provided in **Figure 47**. On the other hand, if we assume that all municipalities are part of the same distribution area and have the same distribution tariff, then the average distribution tariff for the municipalities is 11,5€MWh, which in addition to the gas transmission costs of 3,9 €/MWh gives a total network cost of 15,4€/MWh.

9.1.3 Environmental considerations

Environmental and social team was involved in the process of GDP preparation from the start of pipeline route definition. Close collaboration with technical team was established and pipeline optimisation has been done. The environmental and social analysis was conducted in order to evaluate projects' potential environmental and social constraints, examine projects' and identify ways of improving project implementation by avoiding potential adverse environmental and social impacts from project activities and enhancing the positive impacts. From the beginning of the route consideration and analysis, EBRD mitigation hierarchy was applied, to avoid and if not possible, to minimize and mitigate all identified impacts.

Throughout the process of routing and assessment, mitigation hierarchy approach was adopted, avoiding environmental or social impacts of the project from the outset of development activities wherever possible.

One of the main goals was avoidance of physical resettlement (urban areas) and significant impacts on biodiversity and cultural heritage, as well as minimisation of economic resettlement.

The environmental and social analysis has been done for the large gasification scenario, and this is applicable to the small gasification scenario, as well.

Based on the description of the main characteristics of GDP, it was concluded that the main impacts can be expected from the development of the gas pipeline network, and accordingly, the SEA Report focuses on analysing possible impacts on certain parts of the environment within the proposed pipeline transport corridors.

The development of the gas pipeline distribution system has not been analysed in detail in the SEA, as they are mostly placed under public roads, in parallel with other communal infrastructure elements, respecting the rules and standards of distance from buildings, other above-ground facilities and parallel underground utilities. from them.

An overview of the state of the environment, including any problems if present is assessed within the SEA report. Existing problems are also detected in the available national strategies and other documents dealing with environmental issues. Following them, environmental protection objectives have been determined to encourage the solution of these problems. During the analysis of the available documentation, no significant existing environmental problems were identified that would be limiting for the construction of the gas pipeline, nor problems that could significantly worsen the construction of the gas pipeline. However, the existing environmental problems on which the environmental protection objectives are determined, have been presented In the SEA report, as well.

The analysis of compliance of GDP implementation with environmental protection objectives is presented in **Table 28**.

TABLE 28 – GDP IMPLEMENTATION WITH ENVIRONMENTAL PROTECTION OBJECTIVES COMPLIANCE ANALYSIS

Environmental issue	Environmental protection objective	Comment
Air and existing emissions load	Improvement of air quality by means of reducing polluting substances emission (SO_2, NOx, PM, CO_2, HCl, HF) from industrial/energy plants by means of transition to fuels with lower content of carbon, e.g., natural gas.	GDP implementation can accomplish realization of this environment protection objective if the gasification extends to industrial plants, as well. Planned gasification may lead to locally improved quality of air in urban places.
Climate and climate change	Prevent transboundary transmission of air pollution Protect structures and plants from flooding and extreme precipitation	National list of indicators NK02 Annual precipitation (state indicator) NK03 Use of substances that damage the ozone layer (pressure indicator) NK04 trend of greenhouse gas emissions (pressure indicator) NK05 Projections of greenhouse gas emissions (pressure indicator)
Geomorphology Landscape	Preserve local values and landscape characteristics Improve landscape protection Enable landscape management and planning	Landscape impact is related to construction and maintenance of gas pipeline, causing rectilinear degradation of landscape physical structure, and the most visible are in the forests in the form of forest clearing. Construction is also causing alteration of natural terrain morphology, and it is most visible in case of crossing over water courses and at steep parts of mountainous terrain. Thus, it is necessary to avoid landscape areas of exceptional value and valuable landscapes, as well as, to organize canyon crossing in the manner not harmful for canyon slopes or basin of water courses.
Waters	Improve and preserve good condition of surface water bodies from chemical and environmental perspective and good condition of ground water from chemical perspective.	Development and use of gas pipeline network is expected to have no impact on the state of aquatic environment due to the fact that gas pipeline as infrastructure facility is not causing emission of waste matter. Possible adversary impact in the process of pipeline construction when crossing water courses shall be of strictly local and temporary character and shall have no adversary impact on the state of water, thus GDP is considered not to be in collision with water protection objectives. It is necessary to bypass zone I of sanitary protection of potable water springs in the process of detailed design of pipeline routes, since all activities are prohibited within this zone with the exception of activities related to water intake, water treatment and transport into water supply system. In addition to this, it is necessary to avoid sanitary protection 2 m belt from the axis of the main water supply pipework and 1 m from the axis of pipework for water supply of up to 200 inhabitants. Construction of structures, installation of devices and activities that may potentially pollute water in any possible manner or jeopardize stability of water supply pipeline is not allowed within the protection belt. There are no limitations related to construction and use of gas pipeline within sanitary protection zones II and III.
Soil and Agriculture	Reduce emission of harmful substances and particles into soil Protect agricultural soil of good quality	GDP implementation is not going to lead to harmful substances and particles emission into soil, nor occupy areas for free livestock use.

	Protect and ensure free area for livestock use Prevent soil erosion	Adversary impact on environmental objectives implementation is not expected due to the fact that pipeline routes were not planned to occupy significant amount of quality agricultural land. Depending on the terrain of planned routes, soil erosion is possible.
Biodiversity and Protected areas	Reduce direct pressure on forest and freshwater habitats and dry grassland and karts habitats, and ensures protection of hot spots of biological diversity Prevent spreading of invasive species	GDP implementation may create local pressure on forest habitats due to the necessity to ensure working and protective areas. In addition to this, local pressure on fresh water habitats is possible depending on selected methods of crossing water courses. Significant impact on karst habitats is not expected, except in the case that planned route is situated in the direct vicinity of speleological structures. Invasive species spreading may be expected in particular on parts of the route passing through forest habitats due to the task to maintain the protective corridor.
Forests and forestry	Contribution to management, preservation and sustainable development of forests and forestry	Construction of gas pipeline, or some of the pipeline routes, is not in any way in collision with generic forests and forestry development goals in Kosovo. Moreover, gas use as an alternative to liquid and solid fossil fuels that may contain high level of sulphur and cause high emission of dust matter (ashes) shall certainly cause reduction of pollution in atmosphere and encouraging sustainable management of forest resources shall impact increased use of biomass as carbon neutral source of energy. Forest area that will need to change use permanently for gas pipeline construction (an area of 5 m from each side of the gas pipeline axis) can in this case be considered insignificant, especially because these are coppice forests without significant economic value.
Cultural heritage	Protect archeological and architectural heritage	Although exceptionally significant adversary impact of gas pipelines on archaeological and architectural heritage is not expected, there are several conflict areas. The impact primarily reflects on potential devastation of discovered and undiscovered archaeological sites and devastation of cultural context, while direct destruction of architectural heritage is excluded due to the obligation to comply with regulations.
Human health	Reduce population exposure to communicable and respiratory diseases	Construction and use of gas pipeline shall not have the potential to cause increasement of communicable diseases and thus it shall not lead to health deterioration.
Population and settlements	Opportunities for the employment of the local population increasement Protect important tourism areas	Although significant impact on population is not anticipated (especially during the period of gas pipeline use and operation), impact on population may be expected in case of routes passing through or in the direct vicinity of populated areas due to occupying land. The impact is manifested in occupying construction area in the width of the safety pipeline zone (around 60 m) within which any further construction shall not be possible. In case of route planning in the manner that they pass in the direct vicinity of already constructed structures, causing damage to land and real estate owners related to reduction of value is possible. Special protection measures for protection of people and property shall be implemented in such cases, aiming at ensuring stability of the gas pipeline and avoiding potential accidents.

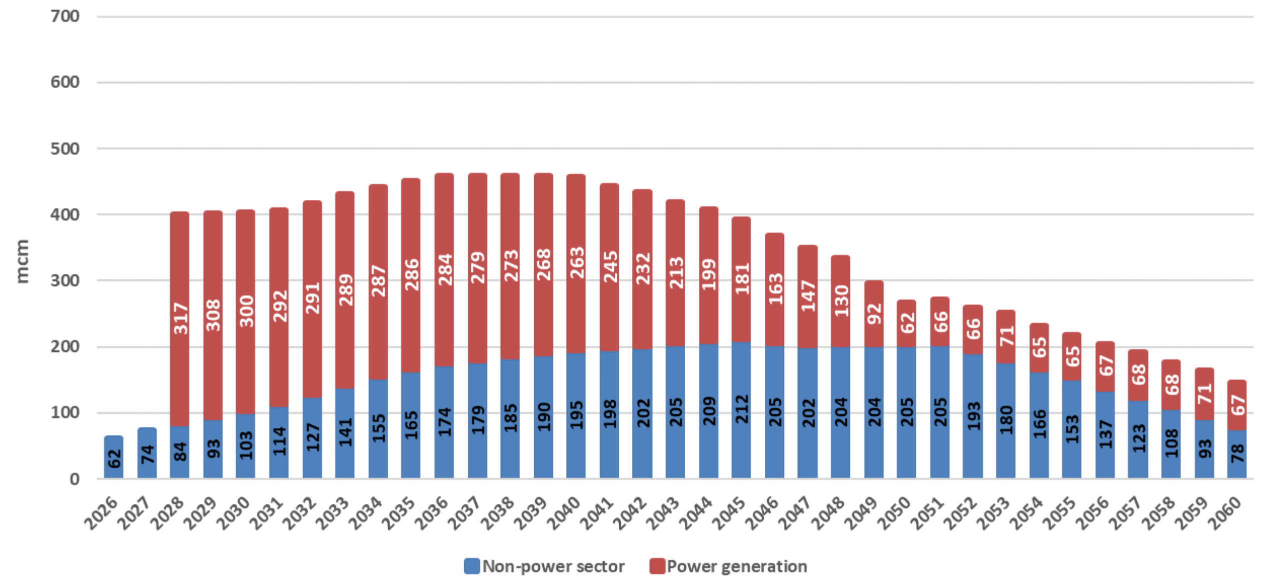
		SEIA has assessed and analysed if populated areas are placed within the gas pipeline route aiming at identifying conflict areas. GDP is not considered to be in collision with population protection and social objectives.

9.2 Small gasification scenario description

Small gasification scenario implies the development of the SKOPRI pipeline. In terms of the distribution areas, this includes: Ferizaj, Viti (Smira), Lipjan, Prishtina (including Obiliq and Fushë Kosovë), Drenas (Ferronikeli), and Hani I Elezit.

The peak hourly gas demand is 157 000 m^3/h (66 000 m^3/h for non-power sector and 91 000 m^3/h for power sector), while the peak annual gas demand is 458 mcm, reached in 2036 (174 mcm in non-power sector and 284 for power generation), as illustrated in **Figure 50**.

FIGURE 50 – GAS DEMAND IN SMALL GASIFICATION SCENARIO



9.2.1 Transmission system parameters

Hydraulic optimization in this scenario resulted in SKOPRI pipe dimension of DN500. The minimum pressure required at the Bulgaria/MKD border should be 45 bar, in order to achieve a pressure of 43 bar in Skopje, which in turn would ensure 30 bar for Prishtina CCGT.

If 54 bar is ensured at the Bulgarian border, the infrastructure envisaged within this scenario enables peak hourly supply of gas of 186.700 m^3/h. This would enable the gasification of additional distribution areas, for example Podujevo, Vushtrri, Mitrovica and Gjilan in addition to the small gasification scenario. As indicated in **Table 26**, the transmission tariff is gradually increasing as the transmission system is expanded further from Drenas. The effect on gas tariff would need to checked for each particular combination of distribution areas to receive gas. If further distribution areas were to receive gas, a compressor station would need to be installed to increase the maximum capacity of DN500 SKOPRI pipeline.

Resulting pipe and hydraulic parameters and respective CAPEX for small gasification scenario are provided in **Table 29**.

TABLE 29 – RESULTS OF HYDRAULIC CALCULATIONS AND CAPEX FOR TRANSMISSION PIPELINES DEVELOPED IN SMALL GASIFICATION SCENARIO

	No	Municipality	District	Section	Length (km)	Diam. (inch)	Pressure at the end of the section (barg)	Total (mil €)
MKD/KOS interconnection	0	Republic of North Macedonia		MKD Conection point - MKD/KOS Border	27,0	20	**39,58**	**N/A**
	1-1	Hani i Elezit	Ferizaj	MKD/KOS Border - BVS Hani i Elezit	0,4	20	**39,74**	
	1-2	Kacanik	Ferizaj	BVS Hani i Elezit - BVS Kacanik	7,5	20	**38,46**	
	1-3	Viti	Ferizaj	BVS Kacanik - Smire	9,8	20	**38,72**	**16,684**
	2	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	20	**37,59**	**11,271**
	3	Ferizaj	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	20		**11,401**
	4	Lipjan	Prishtina	PRMS Banulla - BVS/PRMS Lipjan	8,0	20	**35,75**	**6,436**
	5	Prishtina	Prishtina	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	20	**35,27**	**5,476**
	6	Obiliq	Prishtina	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	20	**34,72**	**10,251**
	SUBTOTAL MKD/KOS Interconnection (w/o MKD section):				**75,5**			**61,519**
Branches	7	Fushë Kosovë	Prishtina	PTS/PRMS Prishtina 1 - PRMS Drenas	14,7	10	**35,16**	**8,389**
	8	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit (Sharrcem) (included in distribution cost, **see Table 30**)	2,7	4	**39,23**	**1,989**
	SUBTOTAL Transmission branch to Drenas (branch to Hani i Elezit in Table 30):				**14,7**			**8,389**
TOTAL Kosovo Gas transmission system (w/o branch to Hani i Elezit):					90,2			69,908

Total distribution network CAPEX is estimated at 130,75 mln €, as provided in **Table 30**. Together with estimated 69,91 mln € of investments in the transmission network, the overall CAPEX in this scenario is 200,66 mln €.

TABLE 30 – TOTAL COST OF DEVELOPING DISTRIBUTION NETWORK FOR SMALL GASIFICATION SCENARIO

No.	Municipality	District	The total cost of developing the distribution network			
			Distribution	Connection to transmission		Total costs
			Costs [mln €]	Length [km]	Costs [mln €]	Costs [mln €]
1	Prishtina	Prishtina	86,78	-	-	86,78
2	Ferizaj	Ferizaj	26,74	-	-	26,74
3	Drenas (Feronikal)	Prishtina	4,64	-	-	4,64
4	Lipjan	Prishtina	5,18	-	-	5,18
5	Viti (Smire)	Gjilan	3,53	-	-	3,53
6	Hani i Elezit	Ferizaj	1,89	2,70	1,99	3,88
Total			**128,76**	**2,7**	**1,99**	**130,75**

9.2.2 Economic and tariff calculations

Small gasification scenario is very similar to the scenario of development of SKOPRI pipeline which is described in Chapter **8.2.2.1**. The differences are:

It is assumed that Podujeve and Gjilan will not be connected to the SKOPRI pipeline. Practical implications are that gas demand in Small gasification scenario is reduced by the amount of gas demand in Podujeve and Gjilan.

Transmission network is extended to Drenas, implying increase in total investment costs.

The resulting gas transmission tariff for Small gasification scenario is 2,28 €/MWh. As the following figure shows, except for Hani I Elezit which has total network costs of 3 €/MWh, network costs for other municipalities range between 11 and 14 €/MWh, which was already stated as an acceptable level of gas transmission tariffs. If instead of separate distribution tariffs for each municipality a single distribution tariff is calculated, average distribution cost is 9 €/MWh. In this scenario total network costs are 11 €/MWh for all municipalities in the Small gasification scenario.

FIGURE 51 – GAS NETWORK COSTS FOR SELECTED CONSUMPTION AREAS IN SMALL GASIFICATION SCENARIO

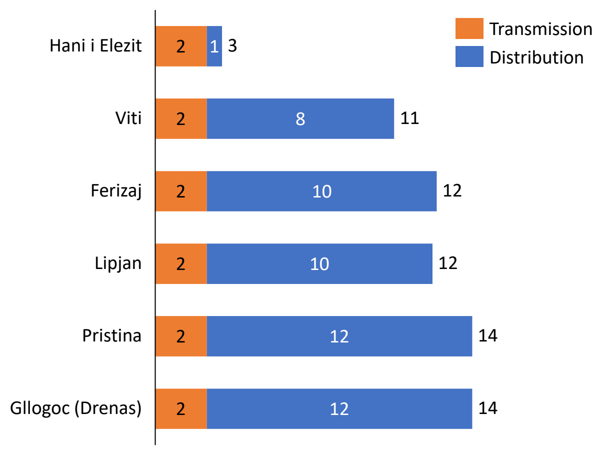
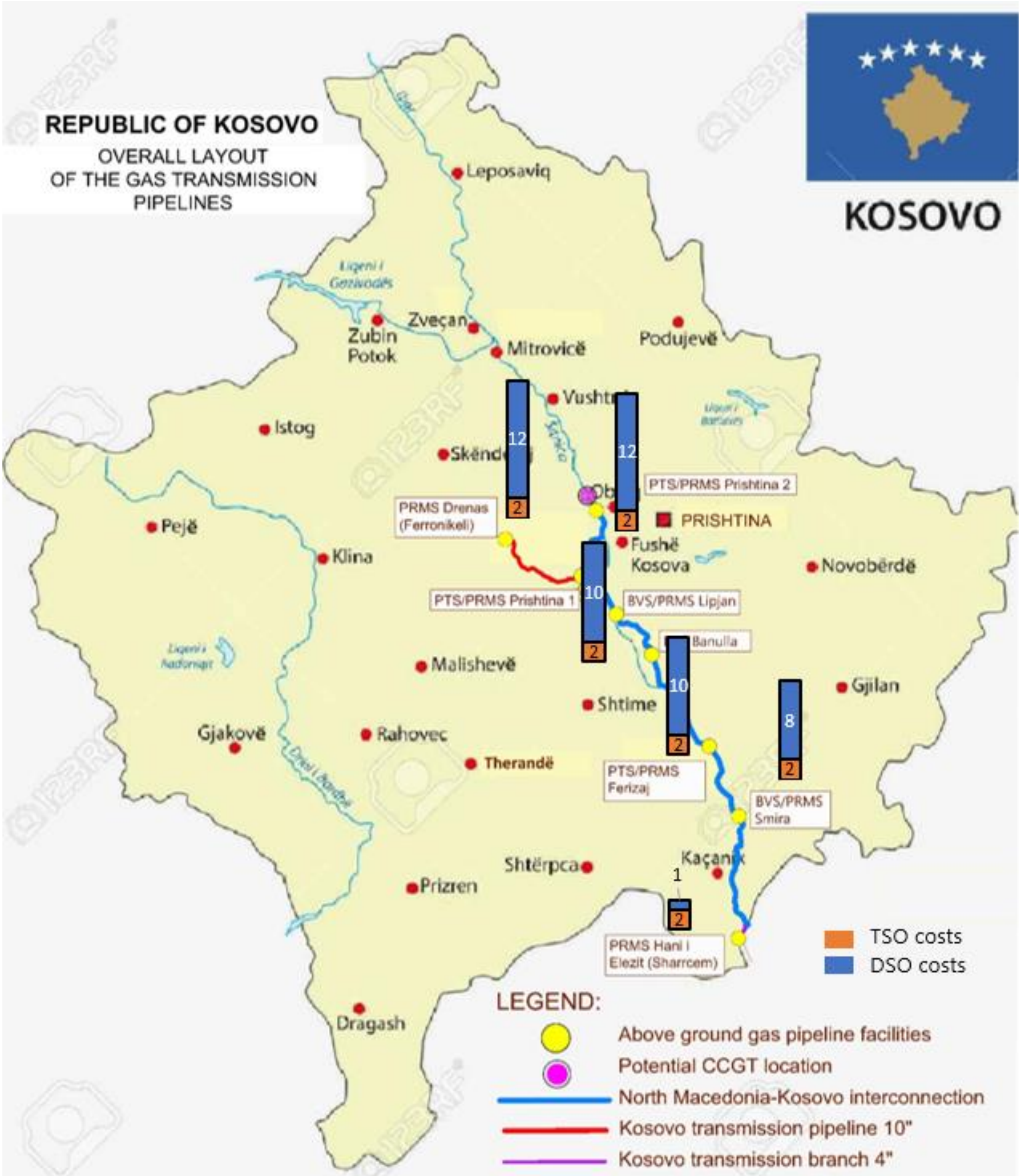


Figure 52 is depicting the Kosovo gas transmission system in small gasification scenario, along with the respective transmission and distribution tariffs.

FIGURE 52 – GEOGRAPHICAL DISTRIBUTION OF GAS NETWORK COSTS FOR SELECTED CONSUMPTION AREAS FOR SMALL GASIFICATION SCENARIO



9.3 Industrial scenario

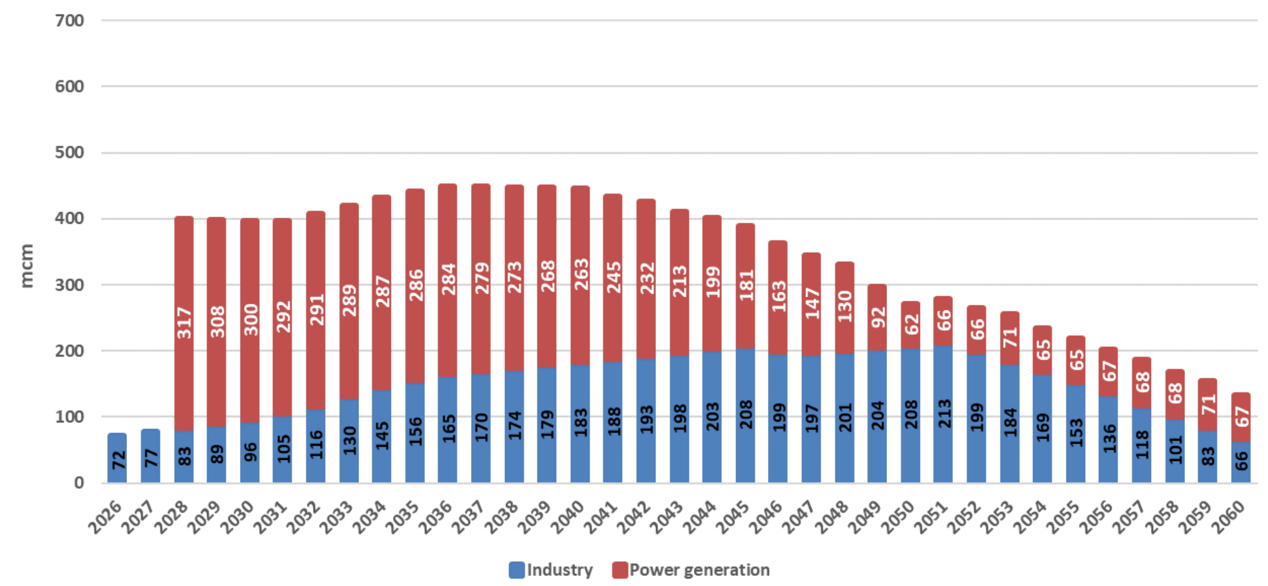
Beneficiary suggested an additional scenario – „industrial scenario". Industrial scenario assumes no gas distribution networks and increased industrial gas demand. Furthermore, no gas ring is envisaged. In case the development of gas ring is not envisaged, the Consultant also assessed an alternative connection route (via Obiliq) to Drenas, Mitrovica and Vushtri.

9.3.1 Gas demand

The industrial scenario assumes the development of the SKOPRI pipeline, and branches to Vushtrri and Mitrovicë. It includes gas demand for power generation, and industrial gas demand is increased by 30%, compared to the projections developed in section **4.1**. As the development of distribution systems is not envisaged, no gas demand from households or services is considered.

The peak hourly gas demand in this scenario is 134 000 m^3/h (43 000 m^3/h for industry sector and 91 000 m^3/h for power sector), while the peak annual gas demand is 449 mcm, reached in 2036 (165 mcm in industry and 284 for power generation), as illustrated in **Figure 53**.

FIGURE 53 – GAS DEMAND IN INDUSTRIAL SCENARIO



9.3.2 Transmission system parameters

The consultant carried out a hydraulic analysis of the scenario in order to determine the optimal diameter of the MKD-KOS gas interconnection pipeline. The transmission system is to include MKD-KOS gas interconnection (SKOPRI) and branches toward Mitrovica and Vushtrri, as well as the Hani i Elezit branch. The hydraulic model (Block Flow Diagram) for this calculation is provided in the report annexes. Due to the reduced transmission capacity requirement, the option of decreased SKOPRI diameter was evaluated (decrease to DN400). The comparison of calculation results to the small gasification scenario is shown in **Table 31** under Industrial DN400 and Industrial DN500 sub-scenarios. It has been concluded that DN400 SKOPRI dimension does not allow for an additional increase in quantities for the potential future needs of the industry for 30% as proposed by the Beneficiary. In Industrial DN500 scenario, when the diameter of the gas pipeline is DN500, it is possible to increase the given industrial consumption by 30%, with the required pressure at the Bulgaria/MKD border of 43 bar.

Further hydraulic analysis showed that the DN500 diameter allowsdoubling the base industrial consumption quantities, with the required pressure at the Bulgaria/MKD border of 45 bar. The results of that scenario are very similar to the results of the small gasification scenario (Scenario 1 in **Table 31**). Therefore, it was concluded that the network layout and parameters as envisaged within the small gasification scenario are suitable for the „industrial gasification scenario".

TABLE 31 – COMPARISON OF HYDRAULIC RESULTS OF INDUSTRIAL GASIFICATION SCENARIOS AGAINST SMALL GASIFICATION SCENARIO

Scenario	Peak gas demand MKD	Peak gas demand KOS	MKD-Greek border Pressure	Bulgaria border pressure	Available Skopje Pressure	SKOPRI Diam.	Prisht. CCGT Pressure
	(m^3/h)	(m^3/h)	(bar)	(bar)	(bar)	DN (mm)	(bar)
KOS GDP, small gasification scenario (households, services and industry + CCGT)							
Small gasification	230 600	157 000	55	**45**	**43**	**500**	**31**
KOS, new design scenarios (industry + CCGT)							
Industrial DN400	230 600	123 300	55	**51**	**49**	**400**	**31**
Industrial DN500	230 600	133 000	55	**43**	**42**	**500**	**33**

Notes:
Required CCGT volume of 91.000 m3/h is included in the Kosovo total.
Scenario *Industrial DN400* shows hydraulic results for the base industrial demand (w/o) increase for 30%, as 30 bar in Prishtina can not be achieved with 30% increased industrial demand , while Scenario *Industrial DN500* shows hydraulic results for the increased industrial demand by 30%.

TABLE 32 – RESULTS OF HYDRAULIC CALCULATIONS AND CAPEX FOR TRANSMISSION PIPELINES DEVELOPED IN DN400 INDUSTRIAL GASIFICATION SCENARIO

	No	Municipality	District	Section	Length (km)	Diam. (inch)	Pressure at the end of the section (barg)	Total (mil €)
MKD/KOS interconnection	0	Republic of North Macedonia		MKD Conection point - MKD/KOS Border	27,0	16	**44,05**	**N/A**
	1-1	Hani i Elezit	Ferizaj	MKD/KOS Border - BVS Hani i Elezit	0,4	16	**34,21**	
	1-2	Kacanik	Ferizaj	BVS Hani i Elezit - BVS Kacanik	7,5	16	**42,48**	
	1-3	Viti	Ferizaj	BVS Kacanik - Smire	9,8	16	**42,32**	**14,182**
	2	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	**16**	40,42	**9,580**
	3	Ferizaj	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	16		**9,691**
	4	Lipjan	Prishtina	PRMS Banulla - BVS/PRMS Lipjan	8,0	**16**	37,10	**5,471**
	5	Prishtina	Prishtina	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	**16**	36,18	**4,654**
	6	Obiliq	Prishtina	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	**16**	34,85	**8,713**
	SUBTOTAL MKD/KOS Interconnection (w/o MKD section):				**75,5**			**52,291**
Branches	7	Fushë Kosovë	Prishtina	PTS/PRMS Prishtina 1 - PRMS Drenas	14,7	10	**35,98**	**8,389**
	8	Drenas	Prishtina	PRMS Drenas- PTS/PRMS Skenderaj	17,7	10	**35,75**	**8,675**
	9	Mitrovicë	Mitrovica	PTS/PRMS Skenderaj – PRMS Mitrovica	16,5	6	**35,53**	**6,545**
	10	Vushtrri	Mitrovica	PRMS Mitrovica – PRMS Vushtrri	7,2	6	**35,42**	**2,808**
	11	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit (Sharrcem)	2,7	4	**44,04**	**1,989**
	SUBTOTAL Transmission branches:				**58,8**			**26,417**
TOTAL Kosovo Gas transmission system:					134,3			78,708

TABLE 33 – RESULTS OF HYDRAULIC CALCULATIONS AND CAPEX FOR TRANSMISSION PIPELINES DEVELOPED IN DN500 INDUSTRIAL GASIFICATION SCENARIO

	No	Municipality	District	Section	Length (km)	Diam. (inch)	Pressure at the end of the section (barg)	Total (mil €)
MKD/KOS interconnection	0	Republic of North Macedonia		MKD Connection point - MKD/KOS Border	27,0	20	**39,17**	**N/A**
	1-1	Hani i Elezit	Ferizaj	MKD/KOS Border - BVS Hani i Elezit	0,4	20	**39,34**	
	1-2	Kacanik	Ferizaj	BVS Hani i Elezit - BVS Kacanik	7,5	20	**38,24**	
	1-3	Viti	Ferizaj	BVS Kacanik - Smire	9,8	20	**38,74**	**16,684**
	2	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	20	**37,95**	**11,271**
	3	Ferizaj	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	20		**11,401**
	4	Lipjan	Prishtina	PRMS Banulla - BVS/PRMS Lipjan	8,0	20	**36,59**	**6,436**
	5	Prishtina	Prishtina	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	20	**36,25**	**5,476**
	6	Obiliq	Prishtina	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	20	**35,84**	**10,251**
				SUBTOTAL MKD/KOS Interconnection (w/o MKD section):	**75,5**			**61,519**
Branches	7	Fushë Kosovë	Prishtina	PTS/PRMS Prishtina 1 - PRMS Drenas	14,7	10	**35,99**	**8,389**
	8	Drenas	Prishtina	PRMS Drenas – PTS/PRMS Skenderaj	17,7	10	**35,71**	**8,675**
	9	Mitrovicë	Mitrovica	PRMS Skenderaj – PRMS Mitrovica	16,5	6	**35,07**	**6,545**
	10	Vushtrri	Mitrovica	PRMS Mitrovica – PTS/PRMS Vushtrri	7,2	6	**34,89**	**2,808**
	11	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit)	2,7	4	**38,23**	**1,989**
				SUBTOTAL Transmission branches:	**58,8**			**26,417**
				TOTAL Kosovo Gas transmission system:	134,3			87,936

For ease of comparison, **Table 32** and **Table 33** include the previously planned branches towards Mitrovica and Vushtrri. However, in case no ring is planned at all, as suggested by the Beneficiary for this scenario, we hereby assess also an alternative, slightly shorter option towards Mitrovica, the new Obiliq-Vushtrri branch, which continues to include the previously planned Mitrovica-Vushtrri branch. The new Obiliq-Vushtrri branch will be further elaborated during the next phase of this assignment (PIP).

Preliminary CAPEX of the gas pipeline section Obiliq – Vushtrri – Mitrovica is given in **Table 34**.

TABLE 34 – PRELIMINARY CAPEX BRANCH OBILIQ – VUSHTRRI - MITROVICA

Municipality	District	Section	Facility	Length (km)	Diam. (inch)	Total (mil €)
Obiliq	Pristina	PTS/ PRMS Prishtina 2 - PRMS Vushtrri	PTS (BVS), BVS	20,4	6	**6,925**
Vushtrri	Mitrovica	PRMS Mitrovica - PRMS Vushtrri	PTS (BVS)	7,2	6	**2,808**

The Kosovo transmission system for the industrial gasification scenario, including alternative Obiliq – Vushtrri – Mitrovica section is presented in **Figure 54**.

FIGURE 54 – KOSOVO TRANSMISSION SYSTEM FOR THE ALTERNATIVE GASIFICATION SCENARIO, INDUSTRIAL

9.3.3 Economic and tariff calculations

The economic and tariff calculations were carried out for the system presented in **Figure 54**. The following figure, **Figure 55**, provides an assumed gas demand. The gas demand shows cumulative gas demand for each of the municipalities during the 2026-2060 period. As the figure shows, the gas demand is driven to a great extent by the gas power plant in Prishtina.

FIGURE 55 – ASSUMED GAS DEMAND FOR THE ALTERNATIVE GASIFICATION SCENARIO, INDUSTRIAL

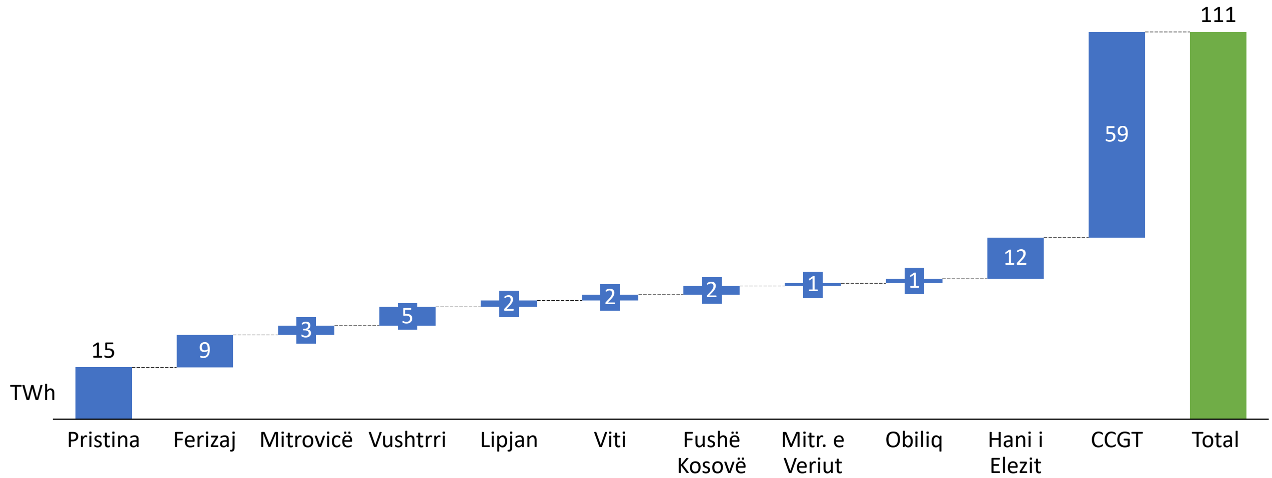


Table 35 presents investment cost for the observed scenario. As the table shows, total investment costs stand at 73.241 million €. The investments are based on the inputs provided in the **Table 33** and **Table 34**. This represents slightly shorter route given that the Beneficiary has indicated that the Ring is not planned for construction.

TABLE 35 – INVESTMENTS COSTS FOR THE INDUSTRIAL GASIFICATION SCENARIO (DN500)

No	Municipality	District	Section	Length (km)	Diam. (inch)	Total (mil €)
0	Republic of North Macedonia		MKD Connection point - MKD/KOS Border	27	20	N/A
1	Hani i Elezit	Ferizaj	MKD/KOS Border - BVS Hani i Elezit	0,4	20	16,684
2	Kacanik	Ferizaj	BVS Hani i Elezit - BVS Kacanik	7,5	20	
3	Viti	Ferizaj	BVS Kacanik - Smire	9,8	20	
4	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	20	11,271
5	Ferizaj	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	20	11,401
6	Lipjan	Prishtina	PRMS Banulla - BVS/PRMS Lipjan	8	20	6,436
7	Prishtina	Prishtina	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	20	5,476
8	Obiliq	Prishtina	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	20	10,251
9	Obiliq	Pristina	PTS/ PRMS Prishtina 2 - PRMS Vushtrri	20,4	6	6,925
10	Vushtrri	Mitrovica	PRMS Mitrovica – PTS/PRMS Vushtrri	7,2	6	2,808
11	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit (Sharrcem)	2,7	4	1,989
Total						**73,241**

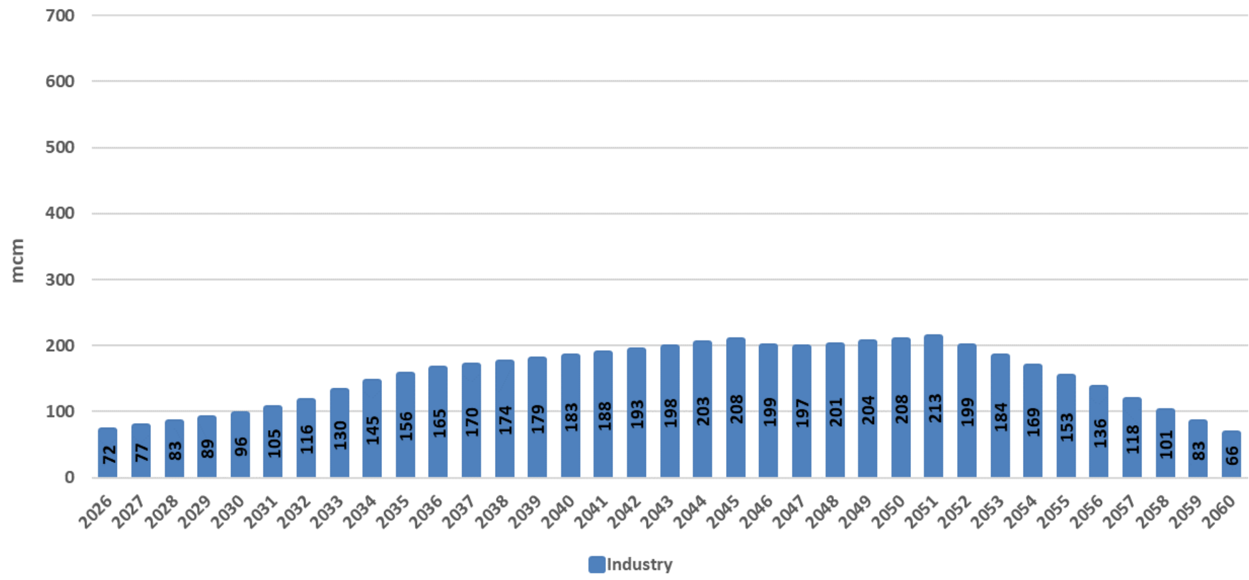
Based on the above gas demand and estimated investment costs, the average gas transmission tariff is calculated at 2,06 €/MWh.

9.4 Industrial only scenario

9.4.1 Gas demand

In this scenario we analyse the impact of scenario with just industrial gas demand, without gas power plant. The assumed gas demand is the same as the one depicted in **Figure 53** and **Figure 55**, just without the amount of gas consumed by the CCGT plant. The peak hourly gas demand in this scenario is 43 000 m^3/h, while the peak annual gas demand is 213 mcm, reached in 2051, as illustrated in **Figure 56**.

FIGURE 56 – GAS DEMAND IN INDUSTRIAL ONLY SCENARIO



9.4.2 Transmission system parameters

Hydraulic modelling showed that Industrial only scenario can be feasible with DN400 SKOPRI interconnection.

9.4.3 Economic and tariff calculations

The economic and tariff calculations were carried out for the system presented in **Figure 54**, and assuming no CCGT power plant. **Figure 55** provides assumed gas demand for each of the municipalities.

FIGURE 57 – ASSUMED GAS DEMAND FOR THE ALTERNATIVE GASIFICATION SCENARIO, INDUSTRIAL

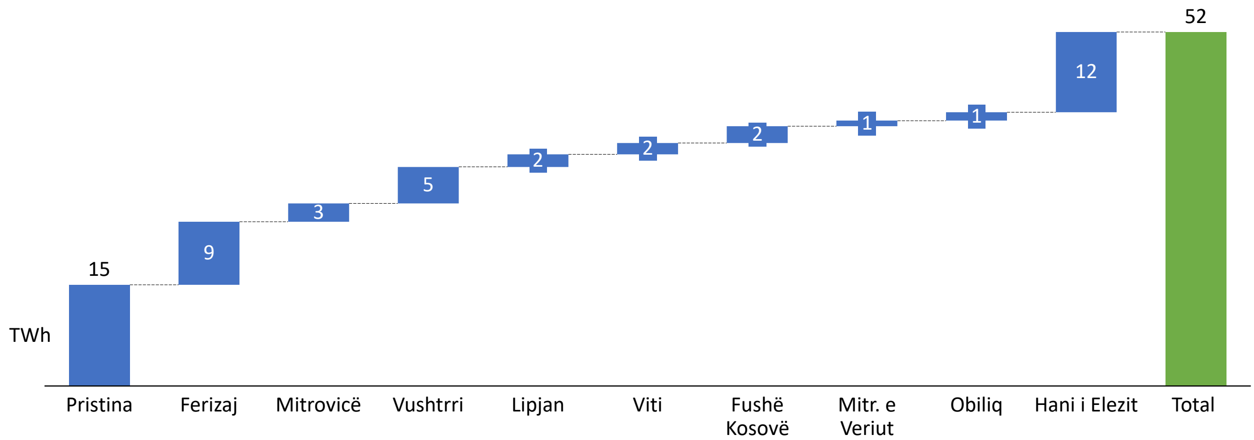


Table 36 provides the investment costs. As indicated, assumed pipeline is of DN400 diameter. Again, as in the previous scenario, the investment costs are lower than those presented in **Table 32** as we have assumed slightly shorter route due to the fact that Ring will not be constructed.

TABLE 36 – INVESTMENTS COSTS FOR THE INDUSTRY ONLY GASIFICATION SCENARIO (DN400)

No.	Municipality	District	Section	Length (km)	Diam. (inch)	Total (mil €)
0	Republic of North Macedonia		MKD Conection point - MKD/KOS Border	27	16	**N/A**
1	Hani i Elezit	Ferizaj	MKD/KOS Border - BVS Hani i Elezit	0,4	16	**14,182**
2	Kacanik	Ferizaj	BVS Hani i Elezit - BVS Kacanik	7,5	16	
3	Viti	Ferizaj	BVS Kacanik - Smire	9,8	16	
4	Ferizaj	Ferizaj	BVS/PRMS Smire - PTS/PRMS Ferizaj	14,2	16	**9,58**
5	Ferizaj	Ferizaj	PTS/RMS Ferizaj - BVS Banulla	16,2	16	**9,691**
6	Lipjan	Prishtina	PRMS Banulla - BVS/PRMS Lipjan	8	16	**5,471**
7	Prishtina	Prishtina	BVS/PRMS Lipjan - PTS/PRMS Prishtina 1	6,7	16	**4,654**
8	Obiliq	Prishtina	PTS/PRMS Prishtina 1 - PTS/PRMS Prishtina 2	12,7	16	**8,713**
9	Obiliq	Pristina	PTS/ PRMS Prishtina 2 - PRMS Vushtrri	20,4	6	**6,925**
10	Vushtrri	Mitrovica	PRMS Mitrovica – PRMS Vushtrri	7,2	6	**2,808**
11	Hani i Elezit	Ferizaj	BVS Hani i Elezit - PRMS Hani i Elezit (Sharrcem)	2,7	4	**1,989**
Total				105,8		**64,013**

Based on the above inputs, the average gas transmission tariff for this Scenario stands at 4,6 €/MWh.

9.5 Notes on the assessed gasification scenario

The gas power plant as an anchor load significantly decrease the transmission tariffs which positively affects all gas consumers. Therefore, without the gas power plant (or other anchor load), the overall cost of gas infrastructure, reflected in tariffs, may be prohibivitely high.

For municipalities on the SKOPRI pipeline (except for Podujevo and Gjilan) total network costs appear to be reasonable according to the current industry standards. On the other hand, due to the high investment costs of constructing the Ring pipeline, total network costs for many municipalities on the Ring pipeline are relatively but still not prohibitively high. Therefore, it is not possible to unequivocally determine the economic viability of supplying these municipalities with gas. In addition, the changes that are expected to take place in the energy sector, which might result in an increase in all energy prices might make the Ring construction economically acceptable. The consultant initally considered two scenarios: Large gasification and Small gasification scenarios. The Beneficiary suggested two additional scenarios; Industrial and Industrial only. Those were assessed as well.

Selection of the preferred scenario determines the recommended parameters (diameter) of the transmission pipelines, namely SKOPRI.

Ministry of Economy of Kosovo, the Beneficiary of this study, has declared the « Industrial Scenario » as its preferred scenario upon which further work should be based.

10 FINANCING OPTIONS

Given that gas transmission is a regulated activity, the profit of the transmission system operator (TSO) is limited by the application of the methodology for calculating the allowed revenue. In addition, the development of a gas network is an infrastructure project that requires the mobilization of significant amounts of capital. Furthermore, given that development of gas infrastructure is a long-term project of high investment cost, it is realistic to expect that the investor needs a significant share of the long-term debt in addition to the equity to finance the project. Consequently, large investment costs, regulated returns, and long-term payback periods imply that only a limited number of institutions will find it attractive to invest in such projects.

Market analysis based on the publicly available data reveals that the potential investor in the Kosovo gas transmission network has the following credit sources at its disposal: loans from the European Investment Bank (EIB), grants through Western Balkans Investment Framework (WBIF), credit lines through the European Bank for Reconstruction and Development (EBRD), and state financing. As for the credit lines offered by the **EIB**, the minimum loan amount is 25 million € with the financing period usually between 4 to 20 years and its purpose include financing a single large investment project or investment program, aligned with one or more priorities of the EIB. Financing terms and conditions of EIB loans, such as maturity, interest rates, and grace period usually form part of the EIB's confidential relationship with its business partners[31]. Typically, coverage of an EIB loan is up to 50% of a project's total cost. Financing is available for public and private entities. A project financed by EIB typically goes through seven major stages:

- Proposal
- Appraisal
- Approval
- Signature
- Disbursement
- Monitoring/reporting
- Repayment

According to the EIB's announcement on their official website on 21 February 2022, the EIB continues to support Kosovo and the Western Balkans under the European Union's Economic and Investment Plan and plans to contribute to decarbonizing the Kosovo economy [32]. In that context switching to modern, low emission gas infrastructure is considered a transition from high fossil fuel dependence (coal) to cleaner energy sources, trying to achieve decarbonization goals. So far, the Bank has supported €300 million worth of projects in Kosovo and provided grants amounting to 12 million € through the Western Balkans Investment Framework (WBIF). The **WBIF** is a joint financial platform of the European Commission, financial organizations, EU Member States, and Norway aimed at enhancing cooperation in public and private sectors investments for the socio-economic development of the region and contributing to the European perspective of the Western Balkans. The plan allocates a substantial financial package of up to 9 billion € in EU funds, identifying 10 investment flagships in the sectors of sustainable transport, clean energy, environment and climate, digital future, human capital, and private sector [33]. WBIF financing options give support to Investing in clean energy putting a strong emphasis on energy market integration, decarbonization and clean energy, just transition, increased digitalization of the system and smart grids, energy efficiency, including modernization of district heating, and energy security. For those countries which are heavily reliant on coal, switching to modern, low emission gas infrastructure is recognized as key to moving away from coal in the short to the medium term. It is believed that switching to gas should offer the region a widely available, secure, and affordable source of energy that

[31] Frequently Asked Questions (eib.org)

[32] EIB will continue to support sustainable development and regional integration of Kosovo*

[33] WBIF 2022 Endorsed Flagship Projects 24.02.22.pdf

will keep the region competitive on an international scale, while significantly improving air quality and lowering emissions.

In addition to the above sources, financing is also possible through loans provided by EBRD. **EBRD** offers loans for larger projects in the amount between 3 and 250 million €. The basis for a loan is the expected cash flow of the project and the ability of the client to repay the loan over the agreed period. Loan denomination is in major foreign or local currencies with the short to long-term maturities up to 15 years (in some cases 18 years for large infrastructural projects) incorporating project-specific grace periods if necessary. Repayments are usually in semi-annual instalments. EBRD loans are based on current market rates and are priced competitively, offering fixed and floating rates [34]. In the calculation of interest rate, a margin that represents a combination of country risk and project-specific risk is added to the base rate (EURIBOR, LIBOR, etc). The calculation and composition of the interest rate offered to the client are confidential to the client and the bank. The bank also provides to its clients hedging possibilities to manage financial risks related to the project's assets and liabilities. This includes hedging of foreign exchange and interest rate risks and commodity price risks. Hedging products offered to the clients include the following: currency swaps, interest rate swaps, caps, collars and options and commodity swaps.

EBRD has financed 84 projects in Kosovo so far with a cumulative investment of 585 million €. Security is required in a form of mortgage on fixed and movable assets, assignment of the company's hard currency and domestic currency earnings, pledge of the sponsor's shares in the company, pledge over the company's bank accounts and assignment of the company's insurance policy and other contractual benefits. One of the main focuses of EBRD financing is supporting green energy transition and strengthening regional integration and connectivity[35]. In the field of energy, EBRD has financed two wind-related projects and one project related to the rehabilitation of selected substations and transformers and strengthening the grid of transmission system and market operator (KOSTT)[36].

Since all analysed sources of financing don't cover 100% of project value, it can be concluded that investors should probably have to combine several sources (own capital, IFI (International Financial Institution) loan and/or state financing if possible).

[34] EBRD loans

[35] The EBRD in Kosovo

[36] Kosovo Transmission Development Project (ebrd.com)

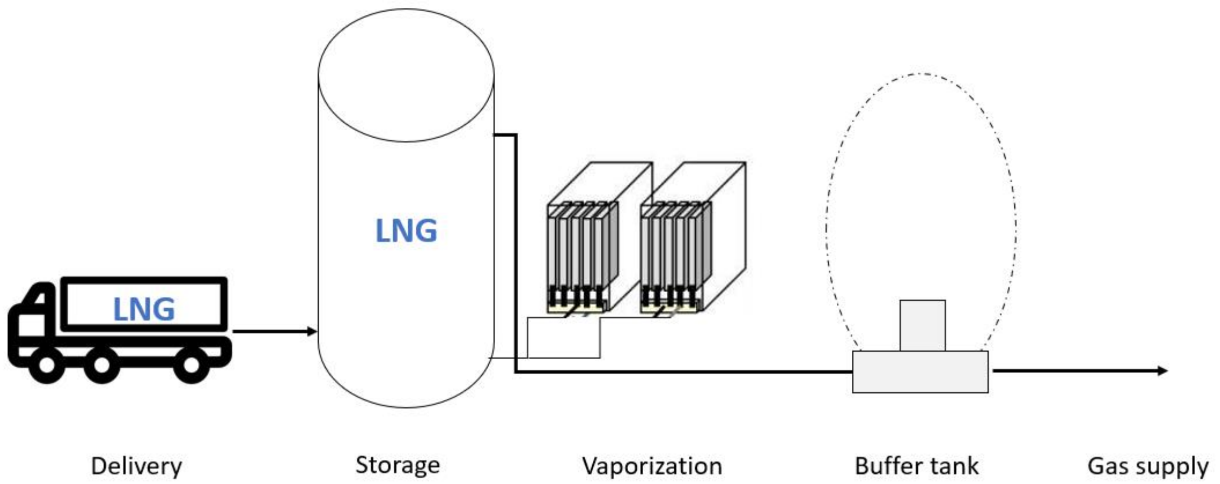
11 ALTERNATIVE GASIFICATION SCENARIOS - SUPPLY OF LNG/CNG

The alternative solution to the construction of natural gas pipelines is the creation of "virtual pipelines". The latter is referred to the alternative method of transporting natural gas to places where there are no pipeline networks available. It is based on a modular system of compression or liquefaction, transport and decompression and/or regasification of natural gas, which communities, industries, gas stations and others can use. In virtual pipelines compressed (CNG) or liquefied (LNG) natural gas is transported by trucks or rail platforms.

11.1 LNG Virtual Pipeline

The concept of LNG virtual pipeline assumes that there is no natural gas transport system (SKOPRI), but gas is brought in LNG form from a nearby LNG import terminal using road or rail. The local facility provides for unloading, storage, regasification and continuous supply to a classic Distribution Network for domestic, commercial or industrial consumers.

FIGURE 58 – GAS SUPPLY CHAIN WITH LNG AS SOURCE



11.1.1 LNG supply optimization methodology

The basic assumption is that the supply of LNG will take place in the following two ways:

by road, using cryogenic trucks, or

by rail, using LNG train tank cars.

In both cases, a stationary LNG storage facility at a location in Prishtina was assumed, which, as dimensioned in each specific year provides a one-week supply disruption reserve.

Optimization of the supply system was performed, considering the following technical parameters:

The average amount of cargo delivered in one truck ride is 20 tons of LNG

LNG truck loading/unloading takes 90 minutes.

The LNG truck is able to make a round trip that includes loading, hauling, unloading and returning to the LNG source in one day.

All LNG trucks delivering cargo should be unloaded within 24 hours period.

The vaporizer capacity corresponds to the highest daily consumption on the coldest projected day in the observed period.

Stationary LNG storage is successively upgraded depending on the expected consumption in a specific year/day.

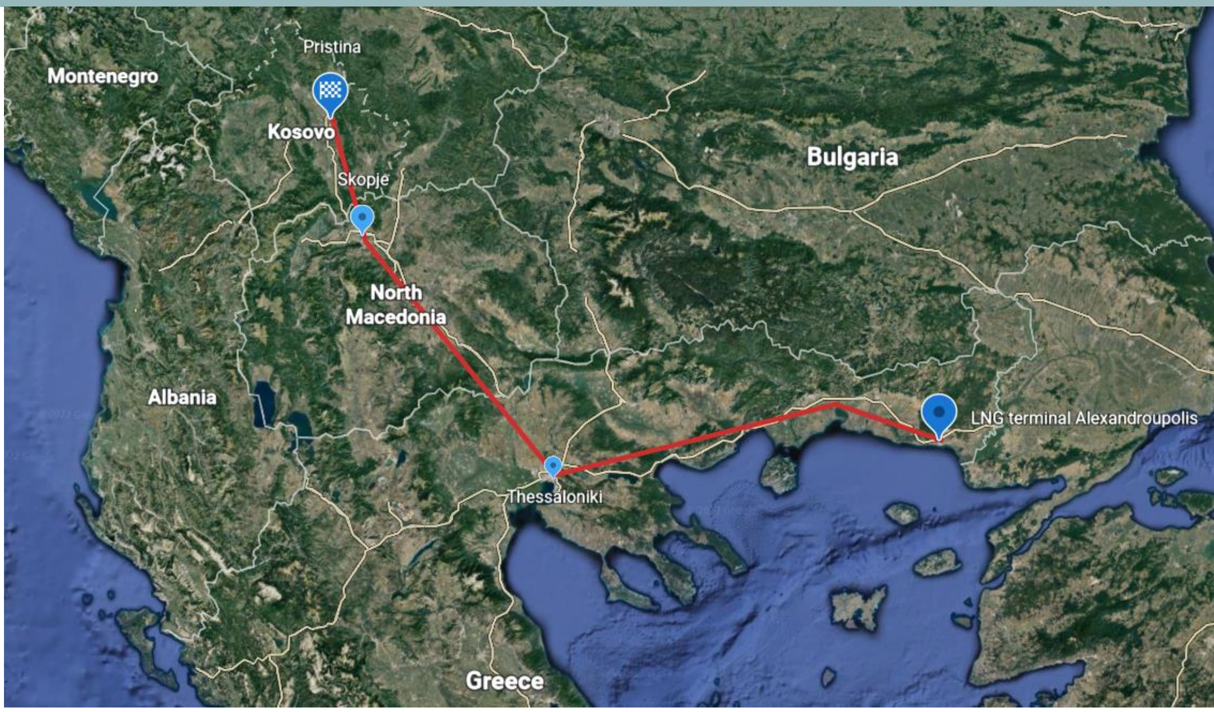
Block train with a volume capacity of one tank wagon of 111 m^3 is assumed for the delivery of LNG by rail (Block train on average involves a platform of 20 tank wagons).

11.1.2 LNG source

Techno-economic analysis implies that LNG will be delivered from the geographically closest point of the LNG source. In this case it is the future LNG terminal in Alexandroupolis. The Terminal is expected to operate by the end of 2023.

Alexandroupoli has road and rail connections to Prishtina, via Thessaloniki in Greece and Skopje in North Macedonia. The road is about 600 km long, which allows the transport of LNG by truck in one day shift.

FIGURE 59 – LNG SUPPLY ROUTE TO PRISHTINA



11.1.3 Supply of Prishtina

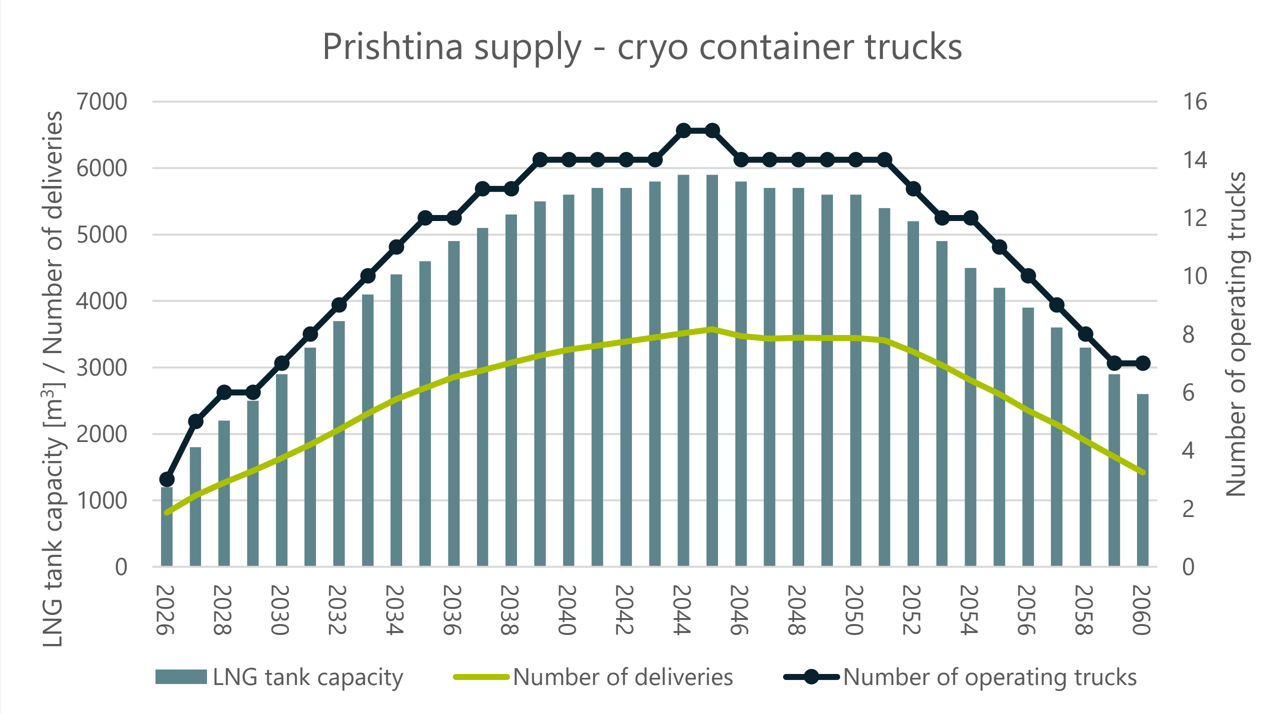
Mathematical optimization of the LNG supply system has been carried out, which considers the continuous supply of natural gas in Prishtina (w/o power generation) in the period up to 2060 as the main function of the goal. In doing so, options for supplying the distribution market by road or rail were considered.

11.1.3.1 Cryo container trucks supply

Peak Gas demand in Prishtina in the observed period can be met by a combination of 15 operating trucks and LNG tank storage with a capacity of 5.900 m^3. In the year of the highest consumption, it is necessary to realize almost 3600 LNG truck deliveries.

Considering that this is a system that is successively dimensioned, in the initial year it is necessary to invest in three (3) operating trucks and in LNG stationary storage with a capacity of 1.200 m^3.

FIGURE 60 – LNG SUPPLY SYSTEM FOR PRISHTINA BY ROAD

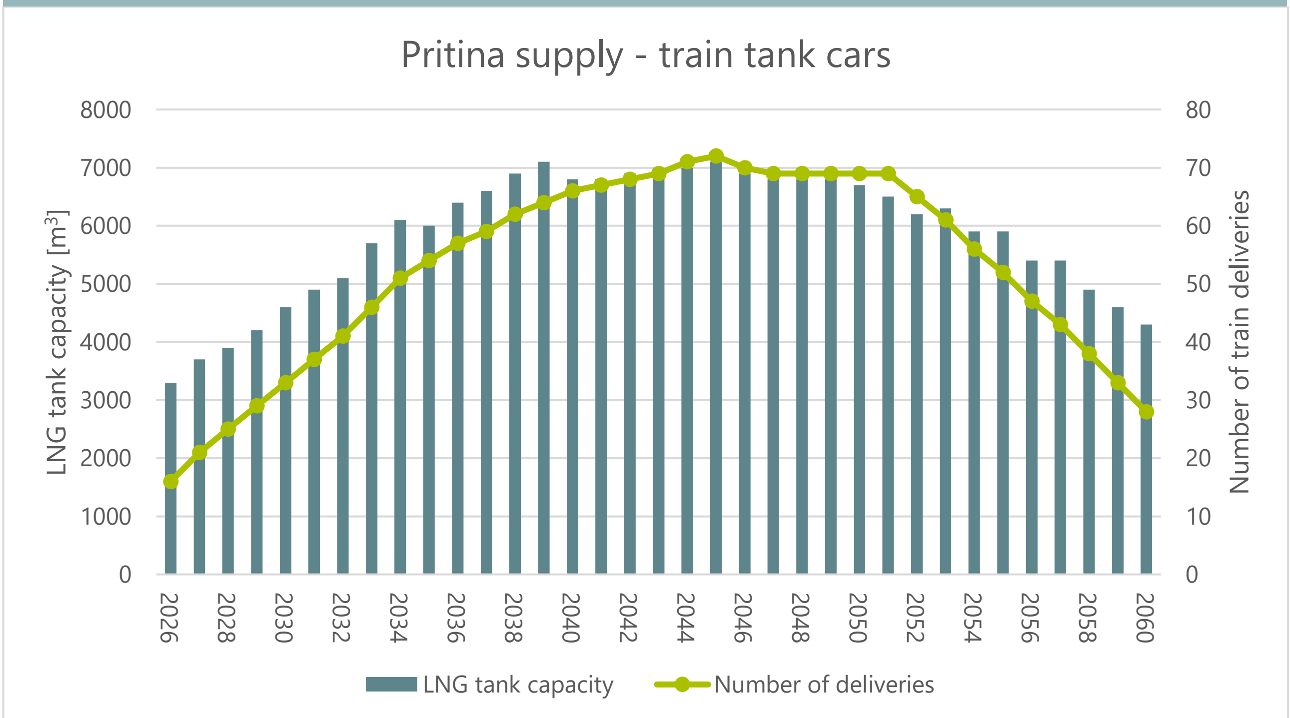


11.1.3.2 Train tank cars supply

In the case of market supply in the Prishtina area by rail, the annual peak gas supply can be met with 72 Block train deliveries.

Given that delivery via rail LNG wagons involves more significant quantities arriving at the destination compared to the road truck, it is initially necessary to construct an LNG storage facility of higher volume capacity (3.300 m^3 in the initial year of the project).

FIGURE 61 – LNG SUPPLY SYSTEM FOR PRISHTINA BY RAIL

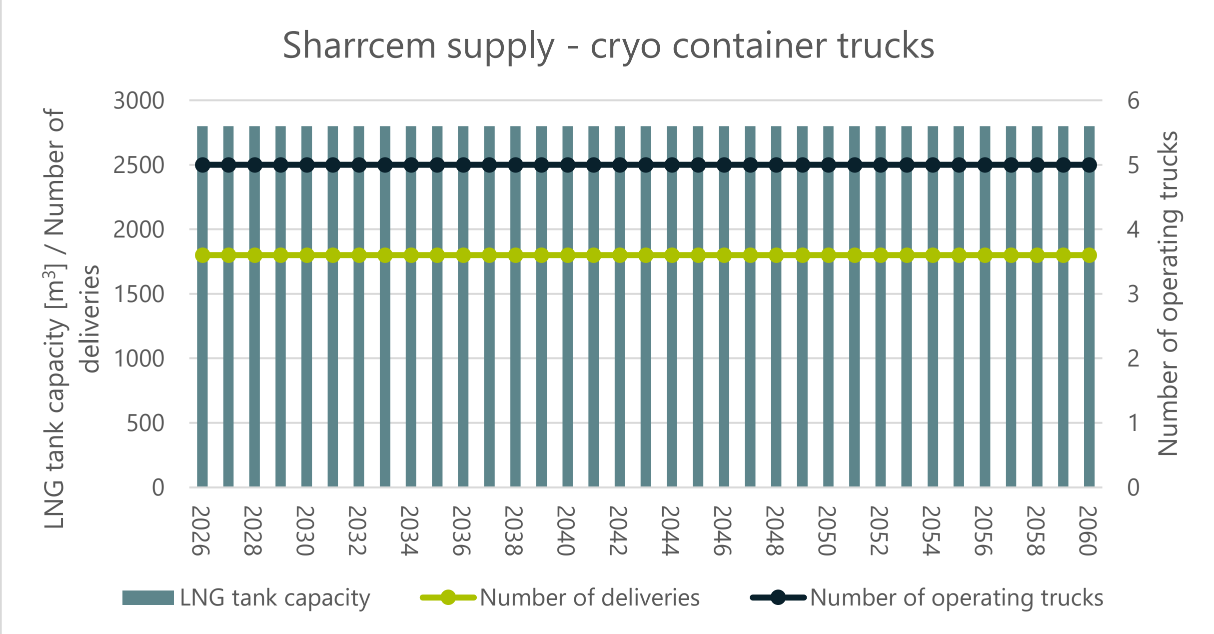


11.1.4 Supply of Sharrcem

From a technical point of view, it is possible to construct an LNG supply chain for a specific industrial consumer.

In the case of Sharrcem, their average annual demand can be met with a total of five (5) operational LNG trucks, and LNG storage capacity of 2.800 m^3. On average, it would be necessary to realize 1.800 truck deliveries a year.

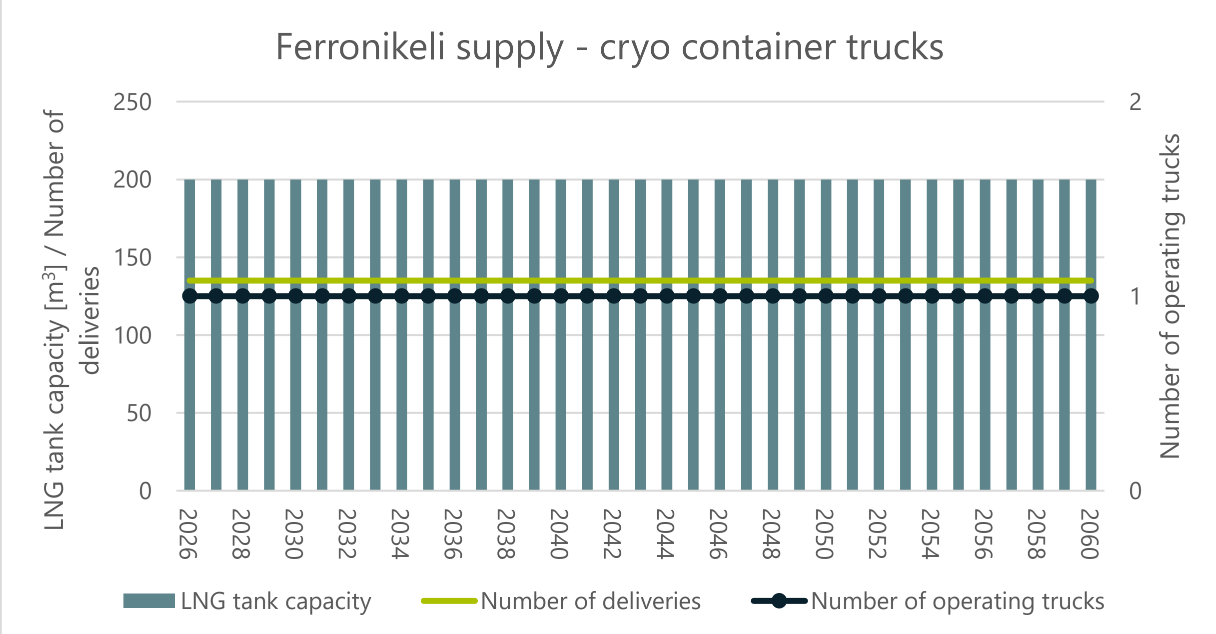
FIGURE 62 – LNG SUPPLY SYSTEM FOR SHARRCEM BY ROAD



11.1.5 Supply of Ferronikeli

The demand of industrial consumer Ferronikeli is significantly lower compared to Sharrcem. In case the LNG supply chain would be organized, one (1) operational LNG truck and LNG storage capacity of 200 m^3 would be sufficient for the technical functioning of the system.

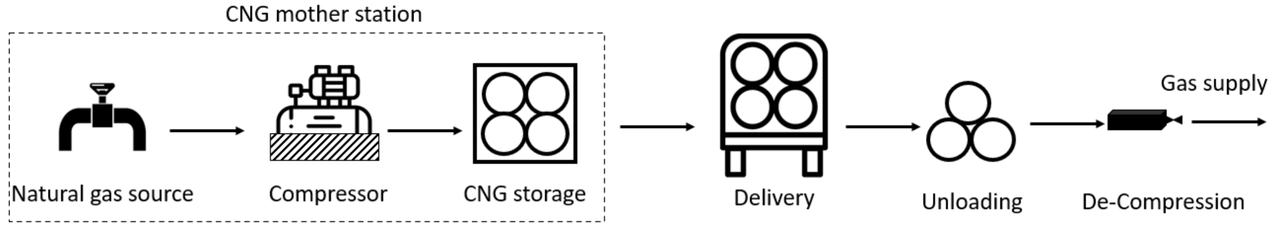
FIGURE 63 – LNG SUPPLY SYSTEM FOR FERRONIKELI BY ROAD



11.2 CNG Virtual Pipeline

The CNG virtual pipeline concept involves a system that allows natural gas transportation in the form of compressed gas using modules coupled to mobile platforms, which are transported by trucks. The supply of CNG in bulk consists of acquisition/receiving from gas pipeline, compression, storage, delivery and decompression for continuous supply to a classic Distribution Network.

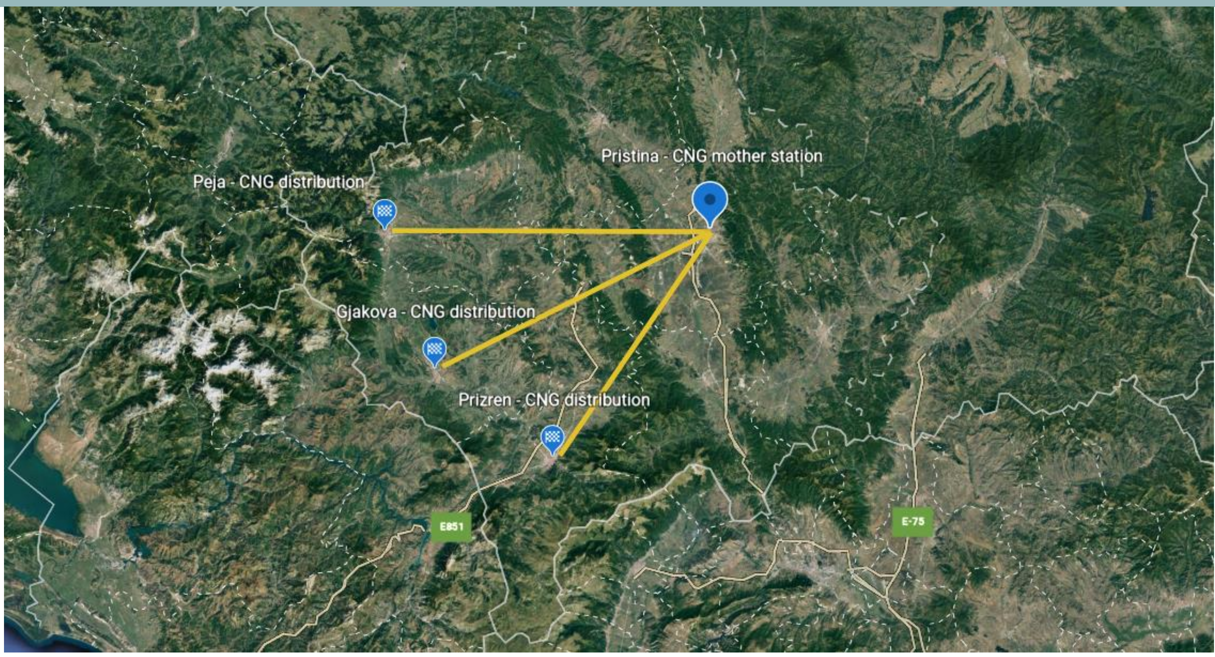
FIGURE 64 – GAS SUPPLY CHAIN WITH CNG AS SOURCE



11.2.1 CNG source

The assumption is that the CNG Mother station will be located in the area of Prishtina (a prerequisite is the construction of the SKOPRI transport gas pipeline). Mother station is a type of filling station that is supplied with natural gas by direct connection to the distribution or transport gas network and is used for filling portable modular tanks. The supply system assumes the transport of CNG modular tanks to decompression stations located in the cities of Peja, Gjakova and Prizren. The length of the supply road routes in no case exceeds 100 km (in one direction).

FIGURE 65 – CNG SUPPLY ROUTE FROM PRISHTINA



11.2.2 CNG supply optimization methodology

The basic assumption is that the supply of CNG will take place by road, using truck trailers.

CNG storage (bundle of modular CNG tanks) is planned at the distribution locations, which is dimensioned in such a way that the supply area can withstand three days of CNG supply disruption in each specific year.

Optimization of the supply system was performed, considering the following technical parameters:

The average amount of cargo delivered in one truck ride is 5.700 m^3 of natural gas.

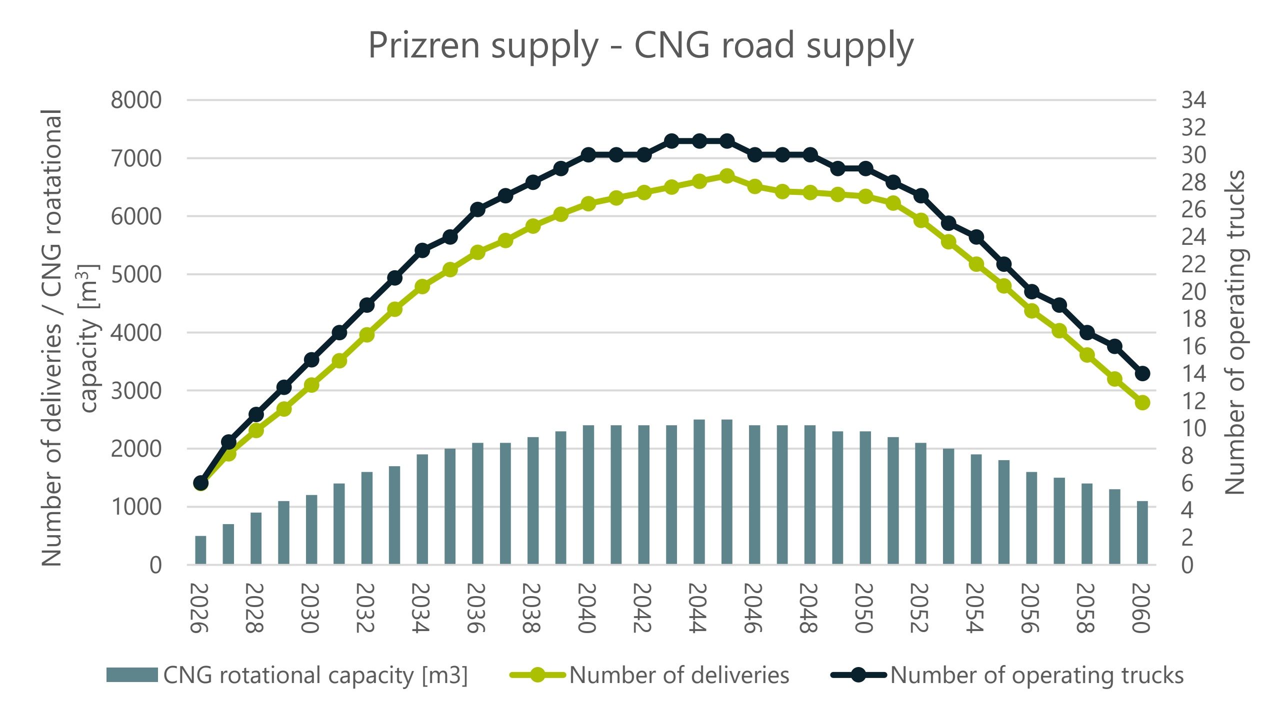
The minimum compressor capacity on the mother station side is 3.000 m^3 (compressor capacity is upgraded depending on the demand of the CNG consumers).

The CNG truck trailer is able to make a round trip that includes loading, hauling, unloading and returning to the CNG source in same day.

11.2.3 Supply of Prizren

To cover Prizren's gas supply in the observed period, 31 operational CNG truck trailers are needed in the peak year, which will realize a total of almost 6.700 deliveries. In addition, for the technical functioning of the system it is necessary to provide 2.500 m^3 of rotational CNG tanks (empty modular CNG tanks that change with full ones during delivery). Considering that the system is being successively upgraded in terms of operational capacities and tanks, in the initial year six (6) operating trucks and 500 m^3 of rotational CNG storage are needed for the continuous supply of the Prizren market.

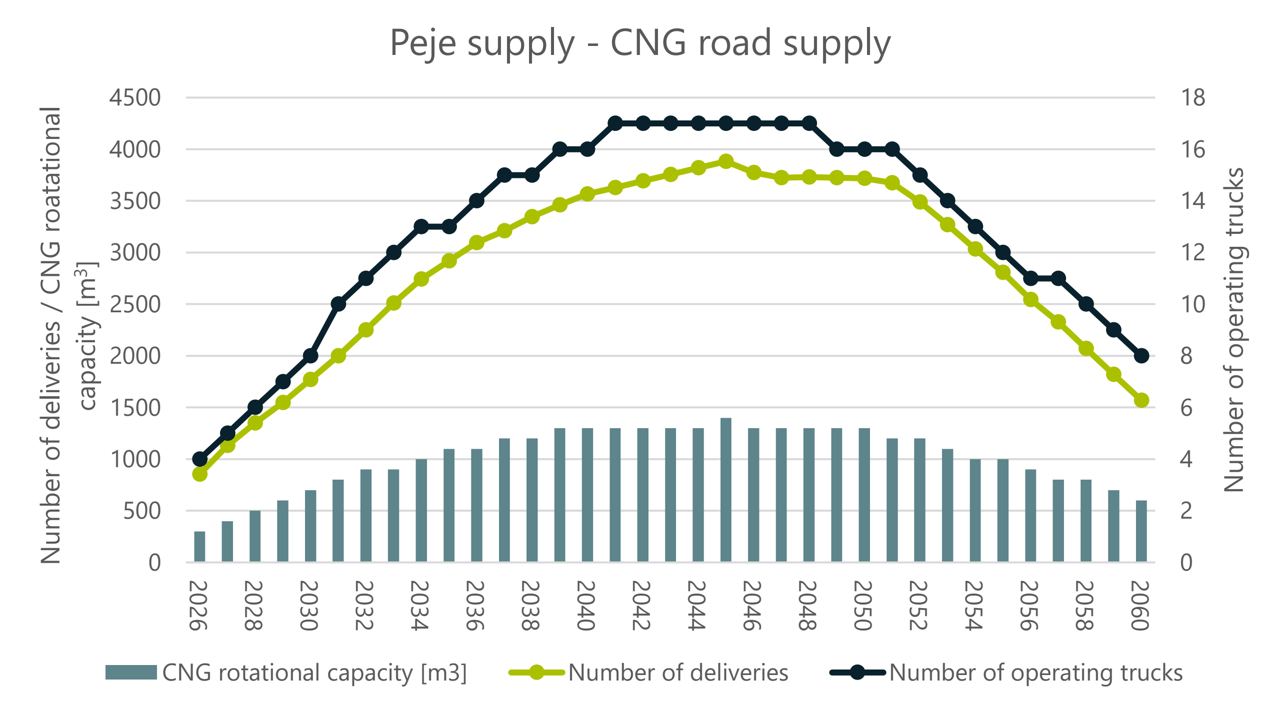
FIGURE 66 – CNG SUPPLY SYSTEM FOR PRIREN



11.2.4 Supply of Peja

Peja demand in peak year can be met with 17 operating trucks and additional CNG storage with a capacity of 1.400 m^3. Trucks should realize almost 3900 deliveries in a specific peak year. In the initial year of the project, four (4) operational trucks are sufficient, while the sufficient capacity of the CNG storage amounts to 300 m^3.

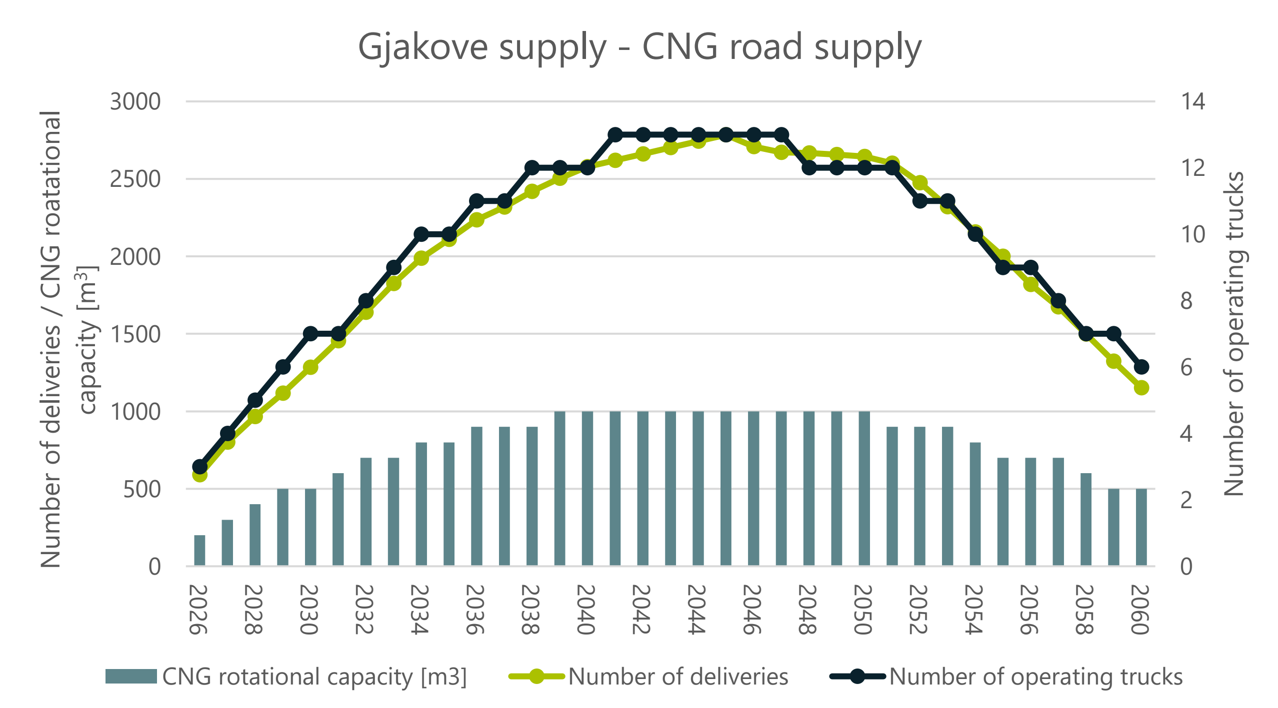
FIGURE 67 – CNG SUPPLY SYSTEM FOR PEJE



11.2.5 Supply of Gjakova

The potential demand of the Gjakova area in the peak year can be covered with 13 operational CNG trucks that would realize a total of about 2.800 deliveries in a specific year. Additionally, a CNG modular storage capacity of 1.000 m³ is required. In the initial year of the project, three (3) trucks and 200 m³ of storage are sufficient to meet the demand.

FIGURE 68 – CNG SUPPLY SYSTEM FOR GJAKOVE



11.3 Financial Assessment

The goal of the financial analysis is to determine the cost of infrastructure required to supply LNG and CNG to the end gas consumers in Kosovo and to calculate the average price (tariff) of providing such services. The analysis aims to assess whether LNG or CNG could represent an alternative to the development of gas transmission and, in the case of a large consumer, distribution network. It is important to stress that the calculated average tariffs do not include the cost of natural gas that would be delivered to final consumers but only the cost of the LNG and CNG infrastructure. In that sense, the tariff for the supply of LNG and CNG is comparable to the tariff for gas transmission and distribution.

To make the comparison between the pipeline gas and gas supplied as LNG and CNG equivalent, it was assumed that the LNG and CNG gas supply would be regulated activities. As in the case of pipeline gas, regulation implies that entities carrying these activities would be entitled to earn an allowed revenue which should be sufficient to cover the operating and maintenance costs, depreciation, and return on the regulated asset base. As in the case of the pipeline gas, it was assumed that the regulated entity would be entitled to the real rate of return equal to 8,3% p.a.

11.4 Supply of LNG

The idea behind the LNG supply is to provide natural gas in large consumption areas. As previously indicated, LNG can be delivered using either road or railway means of transportation. In the case of road transportation by LNG trucks, the LNG can be delivered to multiple consumption areas. Delivery of LNG by train is more limited in the sense that the rail network reaches only certain areas.

In the case of road transport, the LNG would serve as a substitute for gas transmission pipeline (Prishtina) and gas transmission and distribution pipeline (Sharrcem and Feronikeli). In Prishtina, once the LNG is delivered to the urban area, it would still be necessary to develop a gas distribution network to distribute the natural gas to the final consumers. In the case of industrial consumers (Ferronikeli and Sharrcem), the LNG would serve as a substitute for both gas transmission and distribution networks as it is possible to install LNG infrastructure at the gate of these industrial consumers.

11.4.1 Road transport

To supply the LNG to locations in Kosovo, investments in the following assets are required with the corresponding cots:

LNG delivery truck: 300.000 €

LNG containers: 2.000 €/m^3

LNG vaporizers: 10 €/m^3 natural gas (the main and backup system is assumed)

Other investments: 25% of investment in containers and vaporizers

Buildings: 20% of investment in containers, vaporizers, and other investments

Other relevant assumptions include:

Depreciation period: 35 years for all equipment and construction, except for trucks which are depreciated in 15 years;

Operating costs for trucks:

Fuel costs: 1,5 €/litre

Mileage: 40 lit/100 km

Round trip: 1.200 km

Time required to complete a round trip: 1 day

Number of drivers per truck: 3

Gross wage per driver: 2.500 €/month

Maintenance and insurance: 30.000 €/truck/year

11.4.1.1 Prishtina

The LNG infrastructure was designed to allow the supply of gas to the urban area only. In other words, if natural gas is delivered to Prishtina (including Obiliq and Fushë Kosovë) in the form of the LNG, it is still necessary to develop a gas distribution network to distribute gas to smaller consumers. Therefore, the LNG represents an alternative to the development of a gas transmission network in Prishtina.

The following figure shows the structure of investment costs for Prishtina LNG which amounts to 29,6 million €. As the following figure shows, major investment components are LNG trucks and LNG containers.

FIGURE 69 – STRUCTURE OF INVESTMENT COSTS IN LNG INFRASTRUCTURE IN PRISHTINA

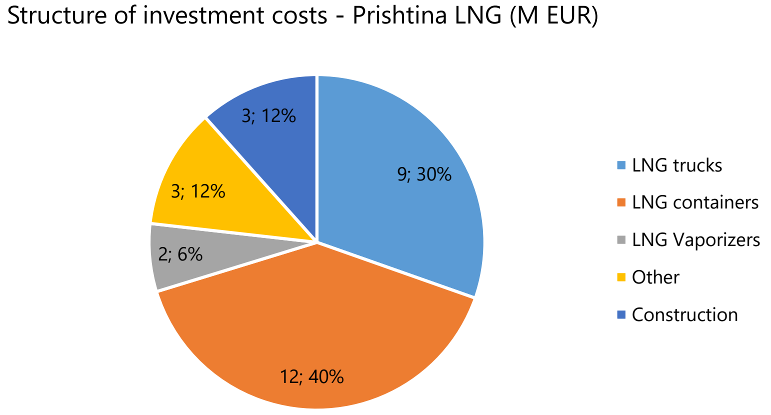
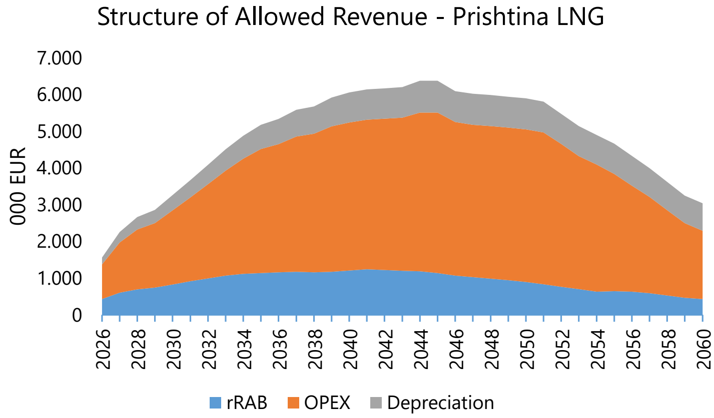


Figure 70 shows the structure of allowed revenue for Prishtina LNG. It is evident that operating costs dominate the allowed revenue, driven primarily by the transportation-related costs (fuel costs and cost of drivers). The allowed revenue result in an average LNG service tariff of slightly below six €/MWh of delivered natural gas.

FIGURE 70 – STRUCTURE OF ALLOWED REVENUE OF PRISHTINA LNG



As was indicated at the beginning of the section, LNG Prishtina would serve the purpose to be a substitute for construction of the gas transmission network. Nevertheless, when the resulting tariff for the LNG Prishtina is compared to the tariffs for the natural gas transmission pipeline, it is evident that LNG Prishtina is not a viable option for the overall gasification of Prishtina. The resulting tariff of just below six €/MWh, though, may be acceptable to specific large consumers if SKOPRI wouldn't be built. Therefore, the Consultant concludes that the supply of LNG to large consumption centers such as Prishtina is not cost competitive when compared to the development of the gas transmission network. Nevertheless, **in case only limited gasification of certain distribution areas or large consumers (that are willing to bear the higher infrastructure cost) is envisaged, LNG supply to Prishtina (or to other large users or distribution areas) may be a viable alternative to gas transmission pipeline**. This is shown for several examples in the following sections.

11.4.1.2 Sharrcem (Hani I Elezit)

The following figure shows the structure of investment costs for Sharrcem LNG which amounts to 13,7 million €. As the following figure shows, dominant investment items are LNG containers and LNG trucks.

FIGURE 71 – STRUCTURE OF INVESTMENT COSTS IN SHARRCEM

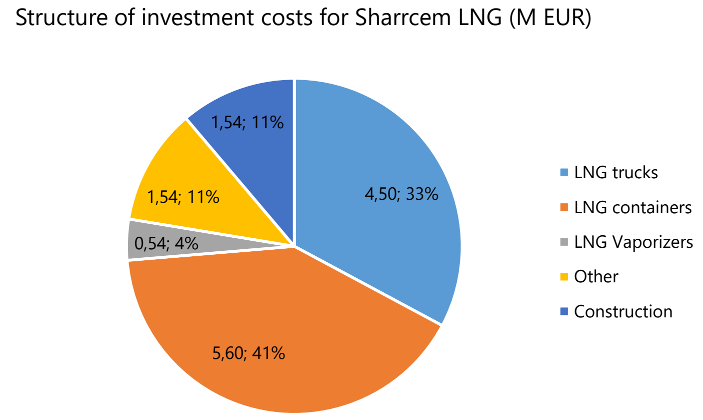
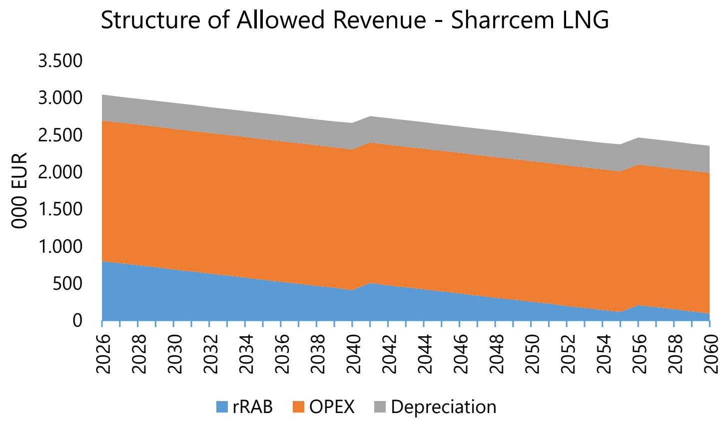


Figure 72 shows the structure of allowed revenue for Sharrcem LNG. It is evident that operating costs dominate the allowed revenue, driven primarily by the transportation-related costs (fuel costs and cost of drivers). The resulting LNG tariff stands slightly below 6 €/MWh.

FIGURE 72 – STRUCTURE OF ALLOWED REVENUE FOR SHARRCEM LNG



The resulting tariff for Sharrcem is higher than the tariff for gas transmission network (in both Large and Small gasification scenario), though the difference is not so significant in the case of the Large gasification scenario. Therefore, the investment in Sharrcem LNG represents an alternative if a gas supply for Sharrcem is required and no gas transmission network in Kosovo exists.

11.4.1.3 Ferronikeli (Drenas)

The following figure shows the structure of investment for Ferronikeli which amounts to 1,55 million €. As the following figure shows, more than half of all investment costs (58%) relate to investments in LNG trucks. Such investment costs result in the LNG tariff of 5,4 €/MWh.

FIGURE 73 – STRUCTURE OF INVESTMENT COSTS

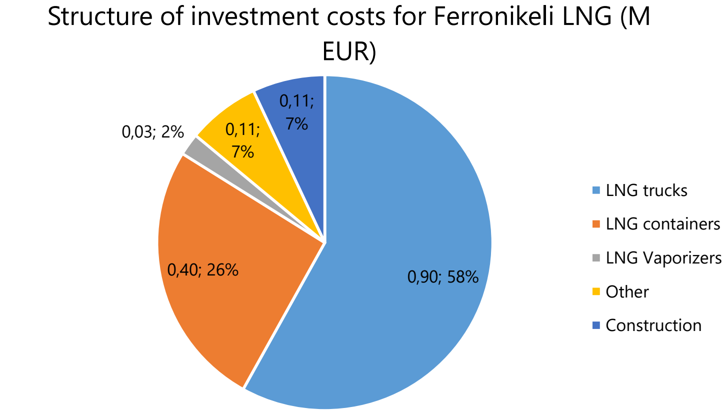
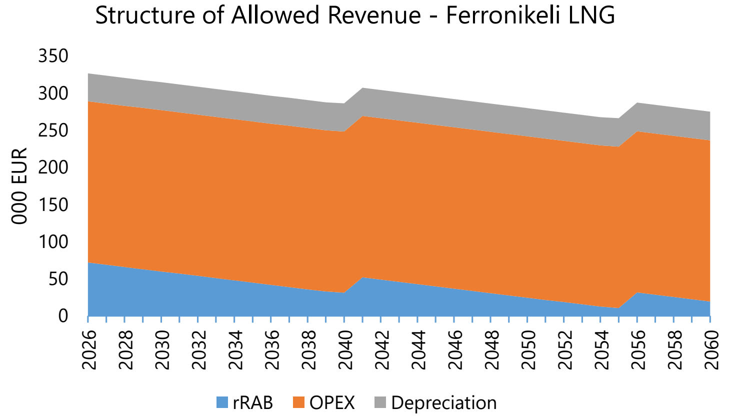


Figure 74 shows the structure of allowed revenue for Ferronikeli LNG. It is evident that just as in the case of Prishtina and Hani I Elezit, operating costs dominate the allowed revenue.

FIGURE 74 – STRUCTURE OF ALLOWED REVENUE OF FERRONIKELI LNG



The LNG tariff of slightly above 5,4 €/MWh can be considered cost competitive when compared to the gas transmission tariff.

11.4.2 Rail transport

As was indicated at the beginning of this section, rail transport of LNG to Prishtina represents a substitute for the development of gas transmission network.

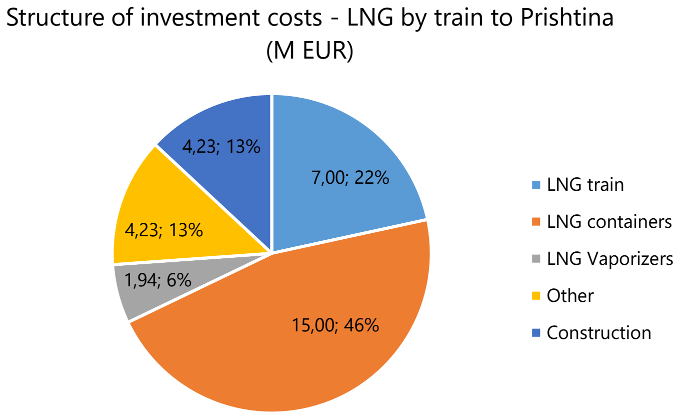
When carrying out the analysis, the following assumptions were made:

Technical life of train carriages: 35 years

Cost of train round trip: 35.000 €

The following figure shows the structure of investment for LNG transport by train to Prishtina which amounts to 32,41 million €. As the following figure shows, slightly less than half of all investment costs are related to investments in LNG containers.

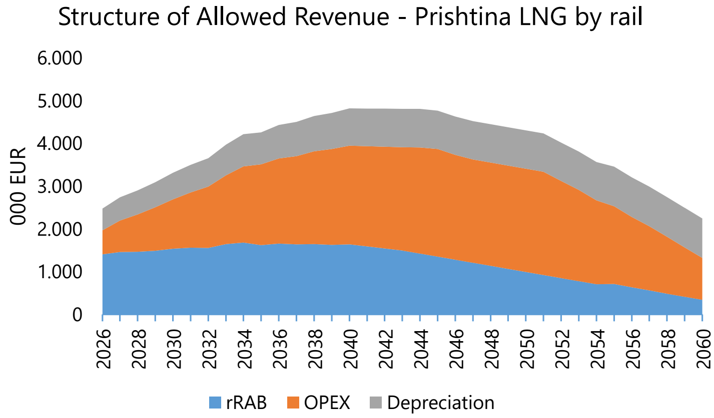
FIGURE 75 – STRUCTURE OF INVESTMENT COSTS IN TRAIN LNG FOR PRISHTINA



The resulting price (tariff) for the rail LNG network is estimated at slightly above 5,3 €/MWh of natural gas. This is marginally lower than in case of LNG supply via road transport.

Figure 76 shows the structure of allowed revenue for Prishtina LNG by rail. Unlike the supply of LNG by trucks where OPEX represents dominant costs, rail supply of LNG is more capital intensive as evident by the larger share of depreciation and return on regulated asset base.

FIGURE 76 – STRUCTURE OF ALLOWED REVENUE FOR PRISHTINA LNG BY RAIL



As was indicated at the beginning of the section, LNG by rail to Prishtina would serve the purpose to be a substitute for the gas transmission pipeline. With the resulting tariff of 5,3 €/MWh, LNG by rail is not a cost-competitive option in the case of the existence of large gas power plant consumers. Nevertheless, **in the case of limited demand, such as the absence of a gas power plant as an anchor consumer, LNG by rail represents an option that should be considered.** On the other hand, LNG supply via rail is not applicable to demand below certain threshold due to minimum rail composition size.

11.4.3 LNG gas supply conclusions

The following table provides a comparison of LNG tariffs for analysed consumption areas. When compared to the development of the gas transmission network, the resulting tariffs are higher and less competitive. Nevertheless, LNG might be considered an option in case there is no gas power plant in Kosovo or for limited gasification of one or more distribution areas and/or large consumers that have the economic case to accept the higher tariff, i.e., in case the overall gas demand in Kosovo is not sufficient to justify the construction of gas transmission network. In addition, unlike the gas pipeline infrastructure, LNG infrastructure has lower probability of becoming a stranded asset.

TABLE 37 – COMPARISON OF LNG TARIFFS

	Tariff [€/MWh]
Prishtina	5,96
Drenas (Ferronikeli)	5,41
Sharrcem	5,91
Prishtina by train	5,26

11.5 Supply of CNG

To assess the cost of supply of CNG, the Consultant analysed three municipalities: Prizren, Peja, and Gjakove. To establish the CNG supply it was assumed that a CNG station would be established in Prishtina. The gas would be compressed and injected into CNG trucks and transported to the municipality and stored in CNG containers.

In the financial aspect, the following CAPEX costs are assumed:

- Truck with trailer and CNG tanks: 400.000 €
- CNG modular storage: 10.000 €/m^3
- CNG mother station (including building, substation, installation, canopy, lighting, fencing, project, permits): 1.900.000 €
- Compressors, high-pressure tank, and electric cabinet (the main and backup system is assumed): 1.150.000 €
- Mass flow meter connection (vehicle and trailer filling): 150.000 €
- Building: an increase of 300.000 € for a successive increase in additional compressor capacity

Other relevant assumptions include:

- Depreciation period
  - CNG Truck and CNG compressor: 15 years
  - CNG container, CNG station, trailer dispenser: 35 years
- Operating costs for trucks:
  - Fuel costs: 1,5 €/litre
  - Mileage: 40 lit/100 km
  - Round trip: 180 km
  - Number of drivers per truck: 1
  - Gross wage per driver: 2.500 €/month
  - Maintenance and insurance: 30.000 €/truck/year

11.5.1.1 Prizren

The following figure shows the structure of investment costs for Prizren. The total estimated investment cost stands at 54,78 million €. Investment in CNG containers at Prizren represents the largest share of total investment and is equal to 44%. The second largest investment category is CNG trucks with a share in a total investment of 40%.

FIGURE 77 – STRUCTURE OF INVESTMENT COSTS

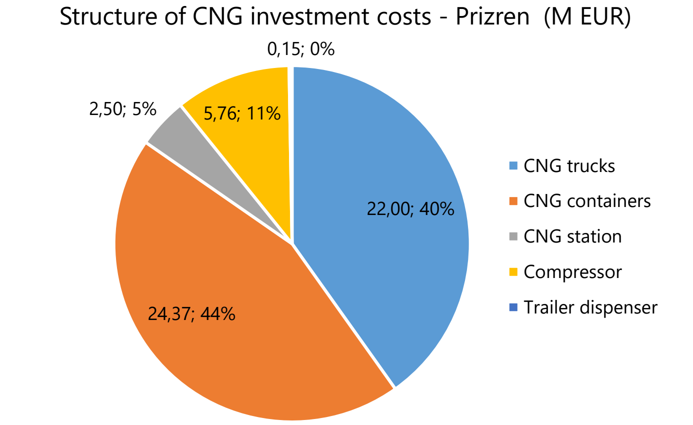
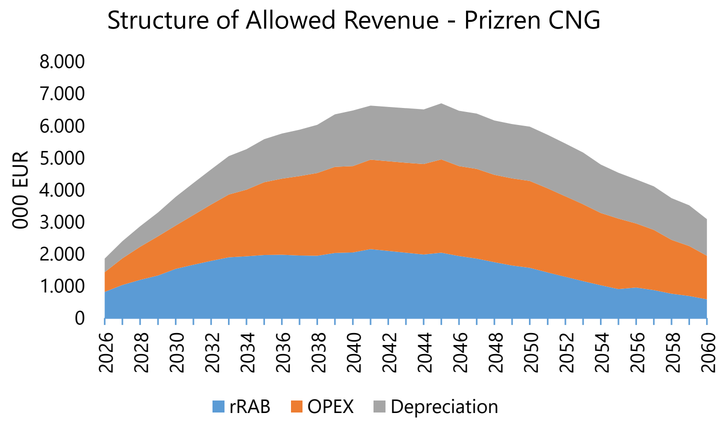


Figure 78 shows the structure of allowed revenue for Prizren CNG option. The analysis results in the average cost of CNG transport for Prizren at slightly above 19 €/MWh of natural gas.

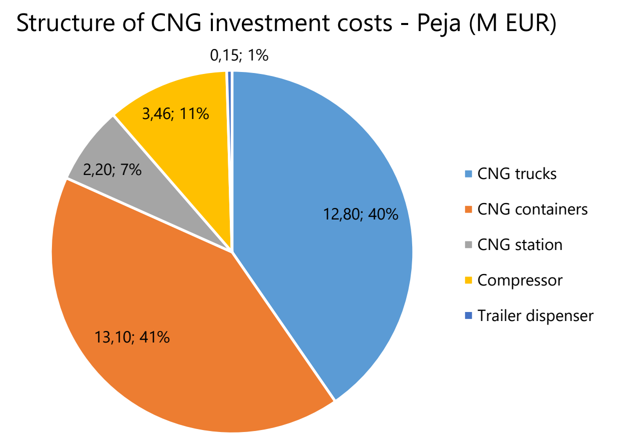
FIGURE 78 – STRUCTURE OF ALLOWED REVENUE FOR PRIZREN CNG



11.5.1.2 Pejë

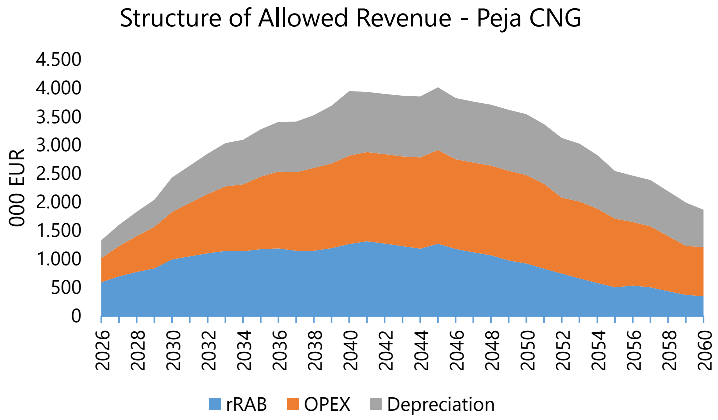
The following figure shows the structure of investment costs for Peja. Total estimated investment costs stand at 31,7 million €. Investment in CNG container at Peja represents the largest share of total investment and is equal to 41%.

FIGURE 79 – STRUCTURE OF INVESTMENT COSTS



The following figure shows the structure of allowed revenue for Peja CNG option. Based on the analysis, the average tariff for CNG Peja stands at slightly below 20 €/MWh.

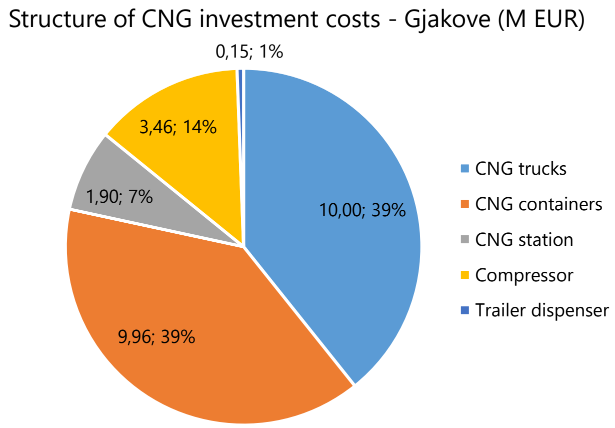
FIGURE 80 – STRUCTURE OF ALLOWED REVENUE FOR PEJA CNG



11.5.1.3 Gjakovë

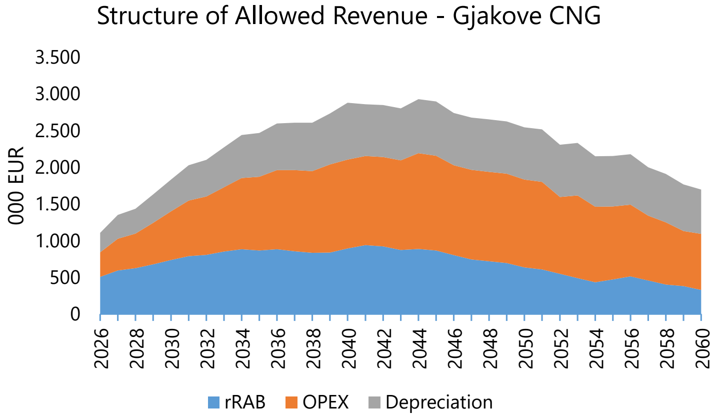
The following figure shows the structure of investment costs for Gjakovë. Total estimated investment costs stand at 25,47 million €. Investment in CNG trucks at Peja represents the largest share of total investment and is equal to 39%.

FIGURE 81 – STRUCTURE OF INVESTMENT COSTS



The following figure shows the structure of allowed revenue for Gjakove CNG option. Based on the analysis, the average tariff for CNG Gjakova stands at around 21 €/MWh.

FIGURE 82 – STRUCTURE OF ALLOWED REVENUE FOR GJAKOVA CNG



11.5.2 Conclusions on CNG supply of gas

The analysis of three possible municipalities to use the CNG shows that the average tariff of CNG infrastructure would be above 19 €/MWh. Such high tariffs make the use of CNG non-competitive in any scenario (small or large gasification). Therefore, the Consultant concludes that CNG may be considered an option only for particular users who have no alternative besides CNG in case no Ring is built.

TABLE 38 – COMPARISON OF CNG TARIFFS

Municipality	Investment	OPEX	Total	Total natural gas demand [GW]	Average tariff [€/MWh]
	[000 €]				
	[1]	[2]	[3]=[1]+[2]	[4]	[5]
Prizren	54.776	75.845	130.621	9.660	19,0
Pejë	34.006	43.307	77.313	5.590	20,0
Gjakovë	25.469	34.512	59.981	4.016	21,1

12 COMPARISON WITH “NO PROJECT”

The decarbonization agenda is fuelled by the EU aims to significantly reduce greenhouse gas emissions by 2050. It will affect all European countries, including Kosovo. The implications of the decarbonization for the energy sector will be phasing out of environmentally unfriendly fossil power plants and an increase in the share of renewable energy.

Natural gas represents a possible transitional path to the decarbonized energy sector of Kosovo. In this scenario, natural gas would replace aging lignite power plants and would provide an energy source for new gas power plant. Taking into account the economic lifetime of the gas network and gas power plants, natural gas could play an important role in the upcoming decades but would be gradually replaced by the more environmentally fuels by the mid-century.

In case Kosovo does not decide to develop a gas network, decarbonization of its energy sector might take a different path. Electricity generation in Kosovo is heavily dependent on lignite power plants. Projections of future retail electricity prices in the recently published study by the Energy Community Secretariat show that the introduction of carbon pricing would render existing lignite power plants noneconomical, driving retail electricity prices up[37].

Furthermore, the introduction of gas networks would contribute to the increased use of gas for heating, enabling substitution away from unsustainable biomass. According to the EUROSTAT data, the share of biomass in the household sector (which is primarily used for heating and cooking purposes) is at two-thirds of the total final energy consumption of households. Therefore, continued reliance on biomass, in addition to being unsustainable, would contribute to the local pollution caused by the combustion of biomass.

In conclusion, scenario without the project would likely contribute to the following:

Rising electricity retail energy prices in Kosovo

Continued reliance on unsustainable biomass and resulting local air pollution

Challenges in accommodating intermittent renewable energy sources into the electricity grid

Increased reliance on imported electricity.

[37] *Energy Community Secretariat, “Carbon Pricing Design for the Energy Community.” 2021. [Online]. Available: https://www.euneighbours.eu/sites/default/files/publications/2021-01/Kantor_carbon_012021.pdf*

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[14] B. Lamb, H. Westberg, R. Kashinkunti, P. Cszepiel, P. Crill, R. Harriss, C. Kolb and J. McManus, "Oxidation of methane in soils from underground natural gas pipeline leaks, GRI-94-0257.35," Gas Research Institute, Chicago, IL, (July 1996).

[15] U.S. Department of Transportation, "RSPA Form No. 7100.2-1(11-85)," U.S. Department of Transportation, Office of Pipeline Safety, Washington, D.C., (1991).

ANNEX 1: BLOCK FLOW DIAGRAMS AND HYDRAULIC CALCULATION MODELS PER SCENARIO

Preliminary hydraulic calculation scenario

This scenario was initially developed to enable estimating the hydraulics of the system and required pipeline parameters. Those, in turn enabled preliminary estimate of CAPEX. Following figure presents Block Flow diagram for the preliminary hydraulic calculation.

FIGURE 83 – BASIC BLOCK FLOW DIAGRAM

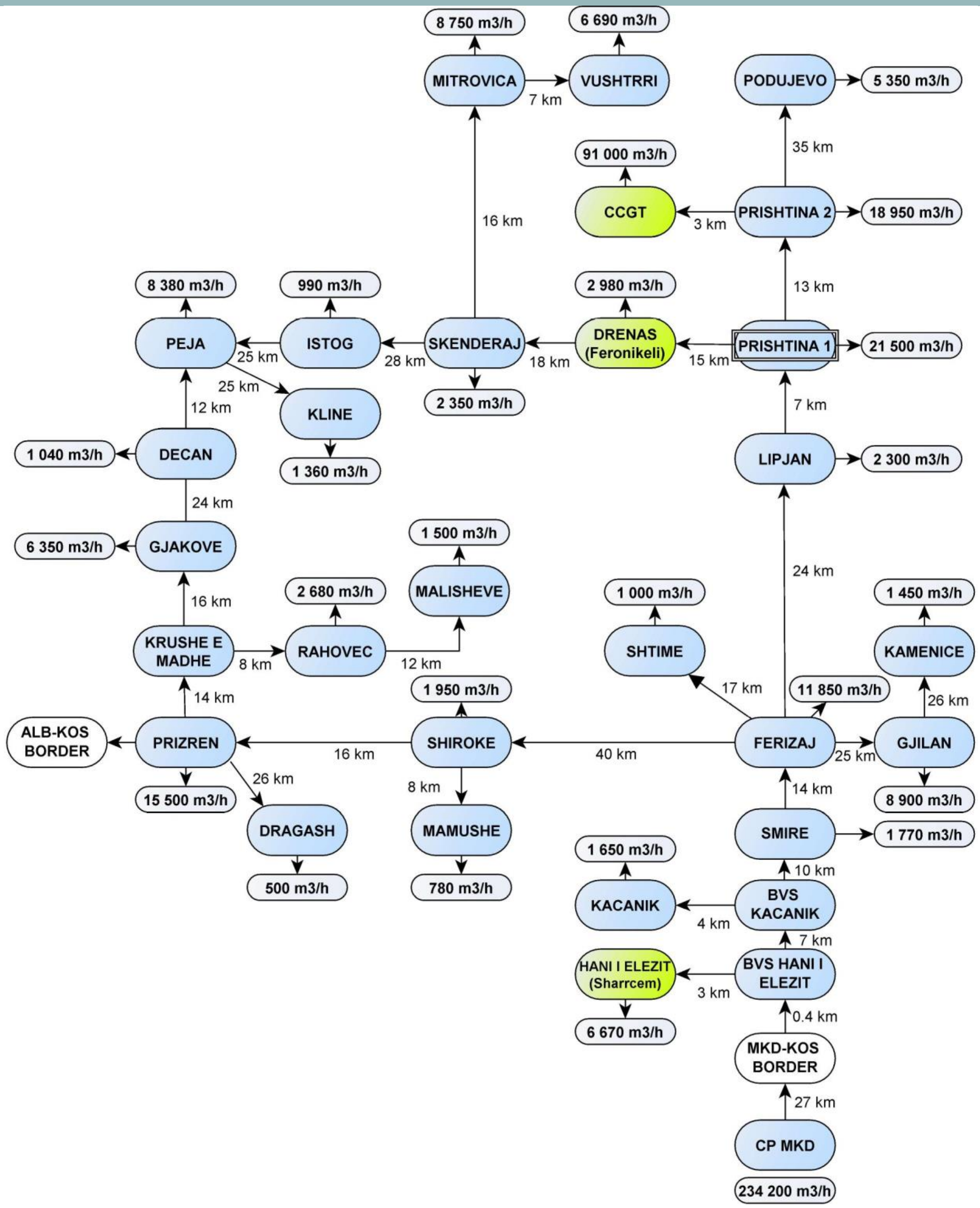


Table 39 shows the results of the hydraulic calculations. The table presents the determined optimal pipeline diameters for each given section and calculated gas pressure at the end of each pipeline section.

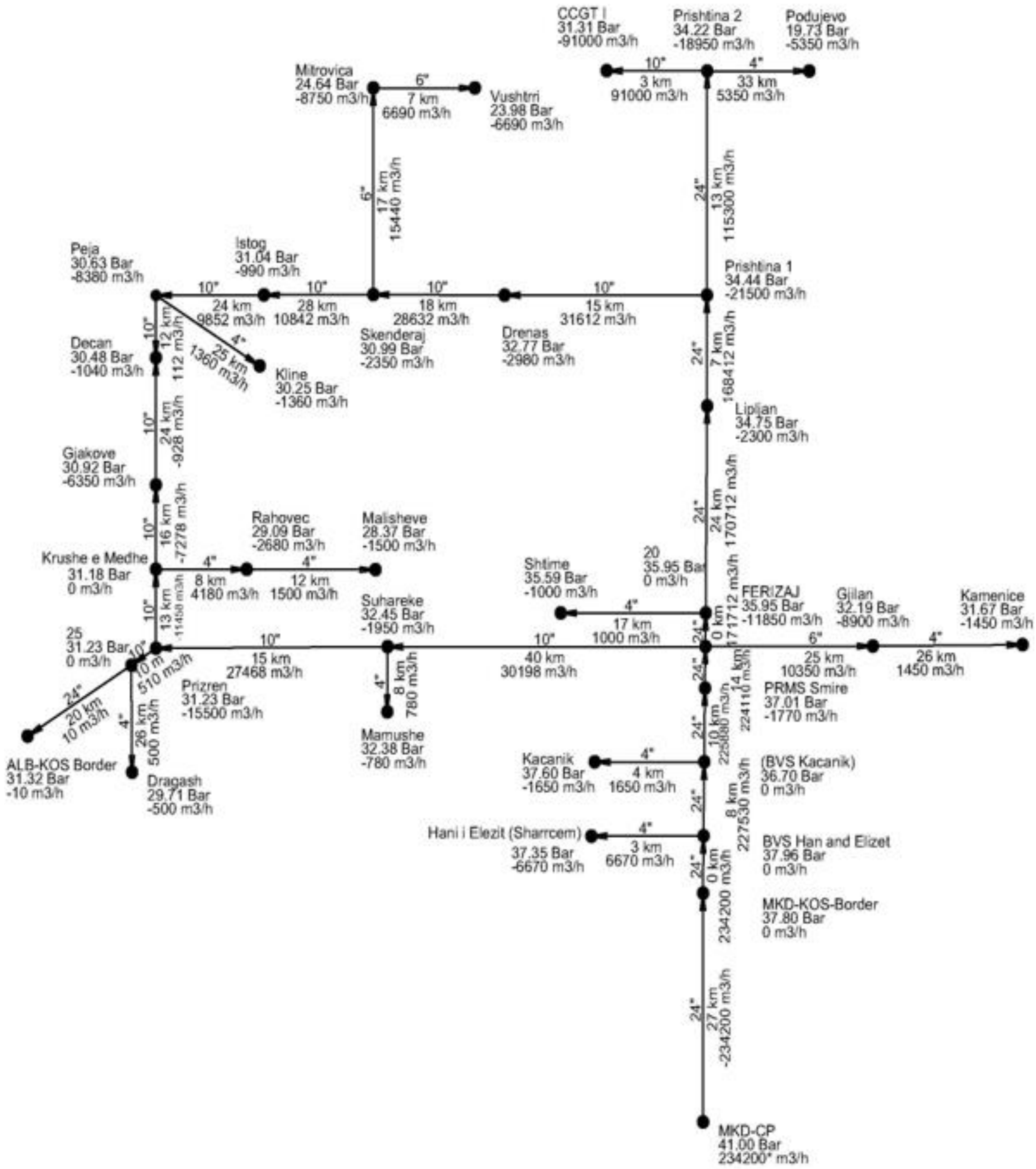
Analyses have shown that for the determined diameters and pressures, 100% of the required heating value (in MWh) will be carried in each pipeline. In relation to that, if hydrogen is transported through the same pipelines having the same diameters, about 75% of the required heating value is carried.

TABLE 39 – RESULTS OF THE PRELIMINARY HYDRAULIC CALCULATIONS

	No	Section	Length (km)	Diam. (inch)	Pressure at the end of the section (barg)
MKD/KOS interconn.	0	MKD Conection point - MKD/KOS Border	27,0	24	**37,80**
	1-1	MKD/KOS Border - BVS Hani i Elezit	0,4	24	**37,96**
	1-2	BVS Hani i Elezit - BVS Kacanik	7,5	24	**36,70**
	2	BVS Kacanik - Smire	9,8	24	**37,01**
	3	Smire - Ferizaj	14,2	24	**35,95**
	4	Ferizaj - Lipjan	24,2	24	**34,75**
	5	Lipjan - Prishtina 1	6,7	24	**34,44**
	6	Prishtina 1 - Prishtina 2	12,7	24	**34,22**
Gas ring	7	Ferizaj - Suharekë	39,6	10	**32,45**
	8	Suharekë - Prizren	15,3	10	**31,23**
	9	Prizren - Krushe e Madhe	13,3	10	**31,18**
	10	Krushe e Madhe - Gjakova	15,5	10	**30,92**
	11	Gjakova - Decan	24,0	10	**30,48**
	12	Decan - Peja	12,0	10	**30,63**
	13	Peja - Istog	24,0	10	**31,04**
	14	Istog - Skenderaj	28,0	10	**30,99**
	15	Drenas - Skenderaj	17,7	10	**30,99**
	16	Prishtina 1 - Drenas	14,7	10	**32,77**
Transmission branches	17	Skenderaj - Mitrovica	16,5	6	**24,64**
	18	Mitrovica - Vushtrri	7,2	6	**23,98**
	19	Ferizaj - Gjilan	24,9	6	**32,19**
	20	Gjilan - Kamenice	26,0	4	**31,67**
	21	Krushe e Madhe - Rahovec	8,0	4	**29,03**
	22	Rahovec - Malisheve	12,0	4	**28,37**
	23	Ferizaj - Shtime	16,7	4	**35,59**
	24	Peja - Kline	25,0	4	**30,25**
	25	BVS Kacanik - Kacanik	4,0	4	**37,60**
	26	Prizren - Dragash	26,0	4	**29,71**
	27	Prishtina 2 - Podujevo	33,0	4	**19,73**
	28	Suhareke - Mamushe	8,0	4	**32,38**
	29	BVS Hani i Elezit - Hani i Elezit (Sharrcem)	2,7	4	**37,35**

Following figure shows the hydraulic model for the preliminary gasification scenario.

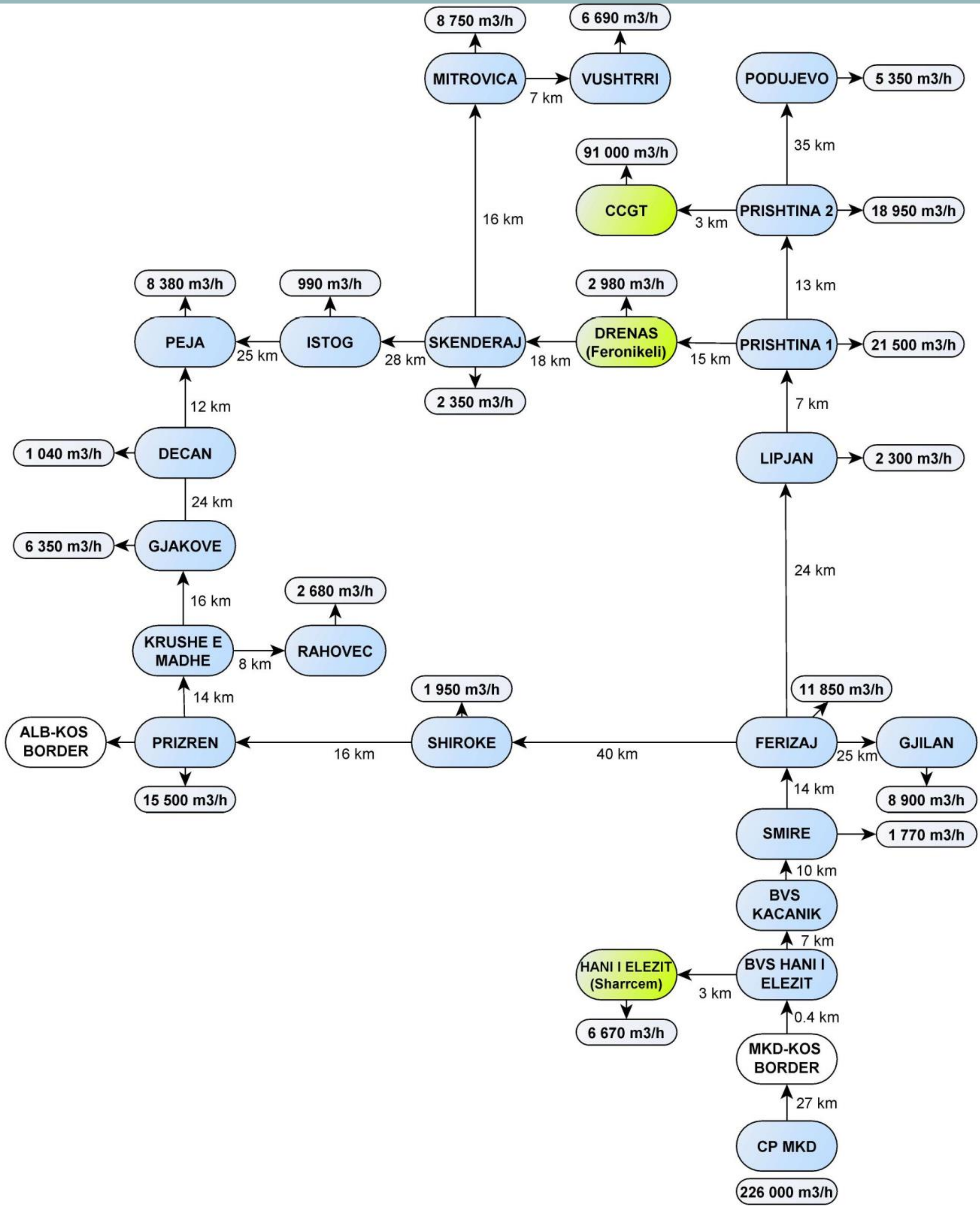
FIGURE 84 – HYDRAULIC MODEL FOR THE PRELIMINARY GASIFICATION SCENARIO



Hydraulic calculation for the large gasification scenario

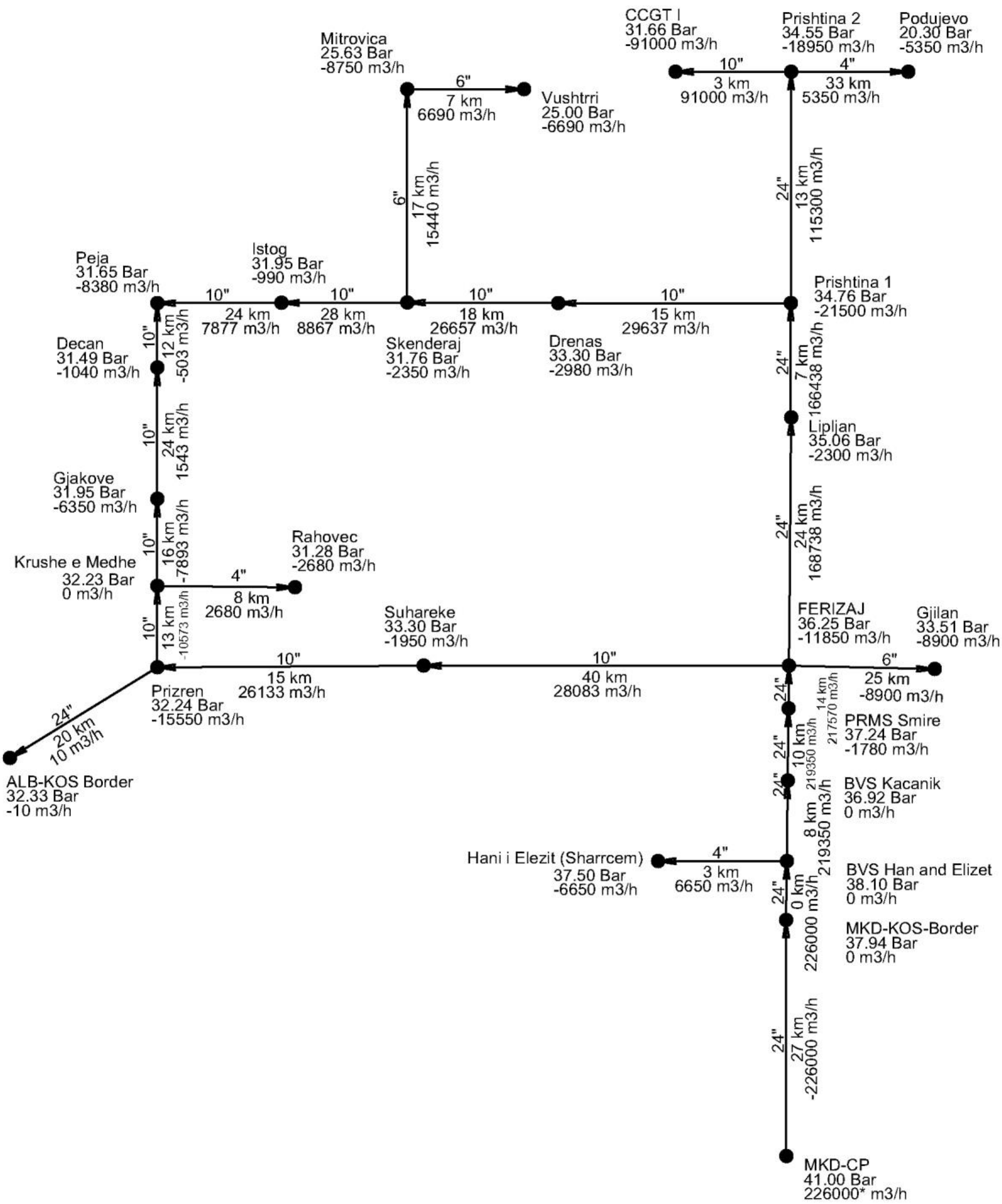
Following figure presents Block Flow diagram for the large gasification scenario.

FIGURE 85 – BLOCK FLOW DIAGRAM FOR THE LARGE GASIFICATION SCENARIO



Following figure presents hydraulic model for the large gasification scenario.

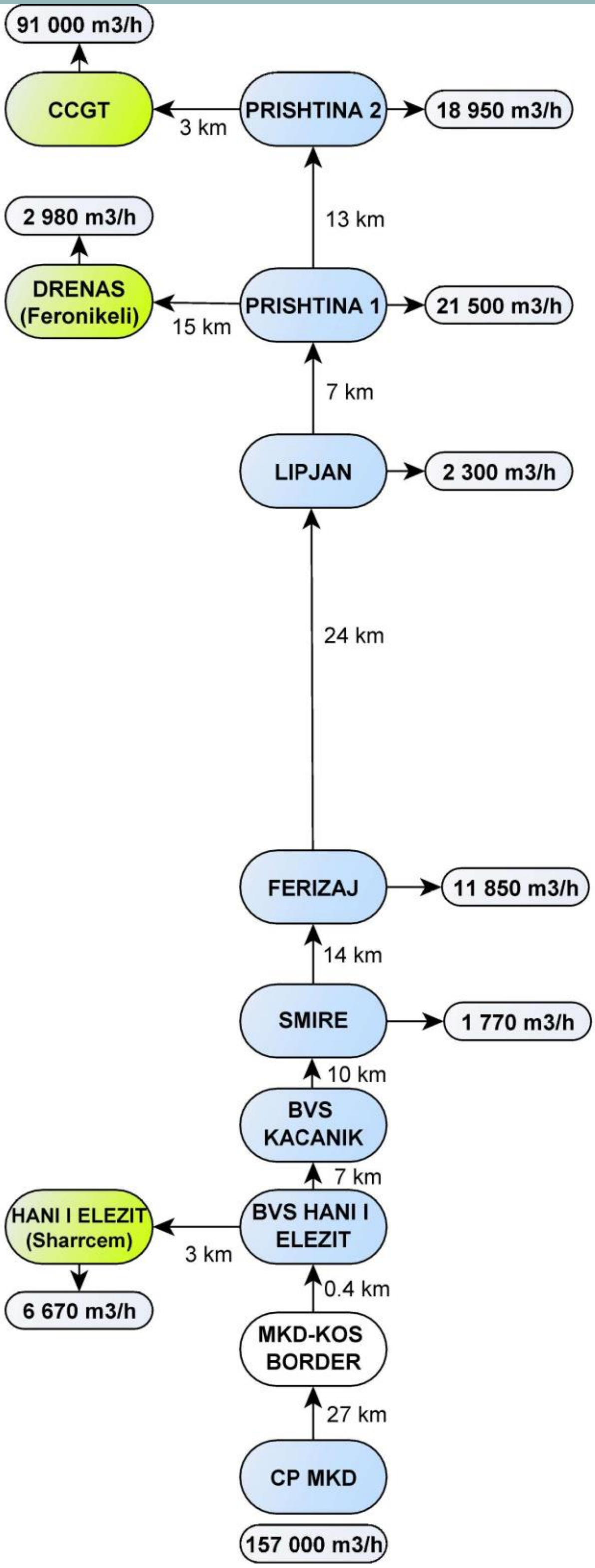
FIGURE 86 – HYDRAULIC MODEL FOR THE LARGE GASIFICATION SCENARIO



Hydraulic calculation for the small gasification scenario

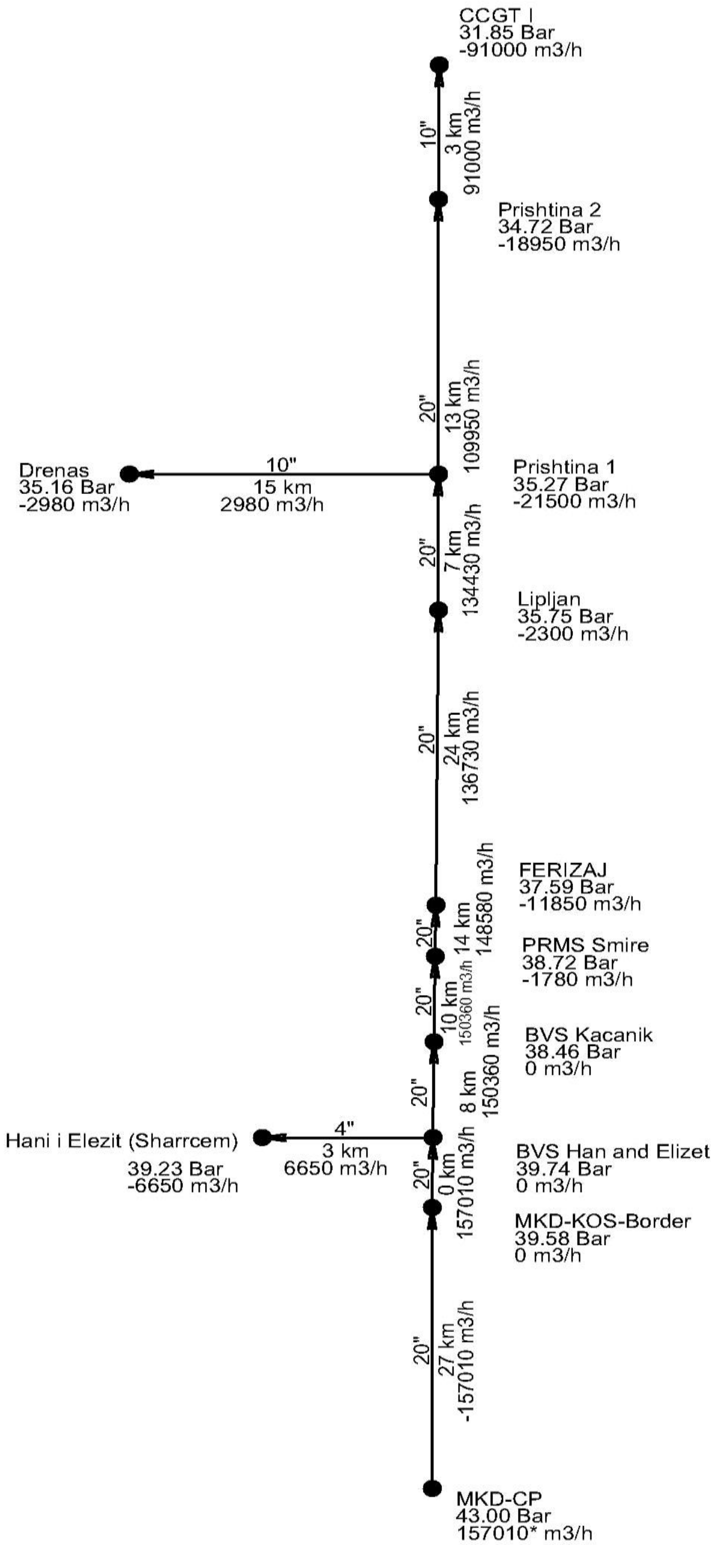
Following figure presents Block Flow diagram for the small gasification scenario.

FIGURE 87 – BLOCK FLOW DIAGRAM FOR THE SMALL GASIFICATION SCENARIO



Following figure presents hydraulic model for the small gasification scenario.

FIGURE 88 – HYDRAULIC MODEL FOR THE SMALL GASIFICATION SCENARIO

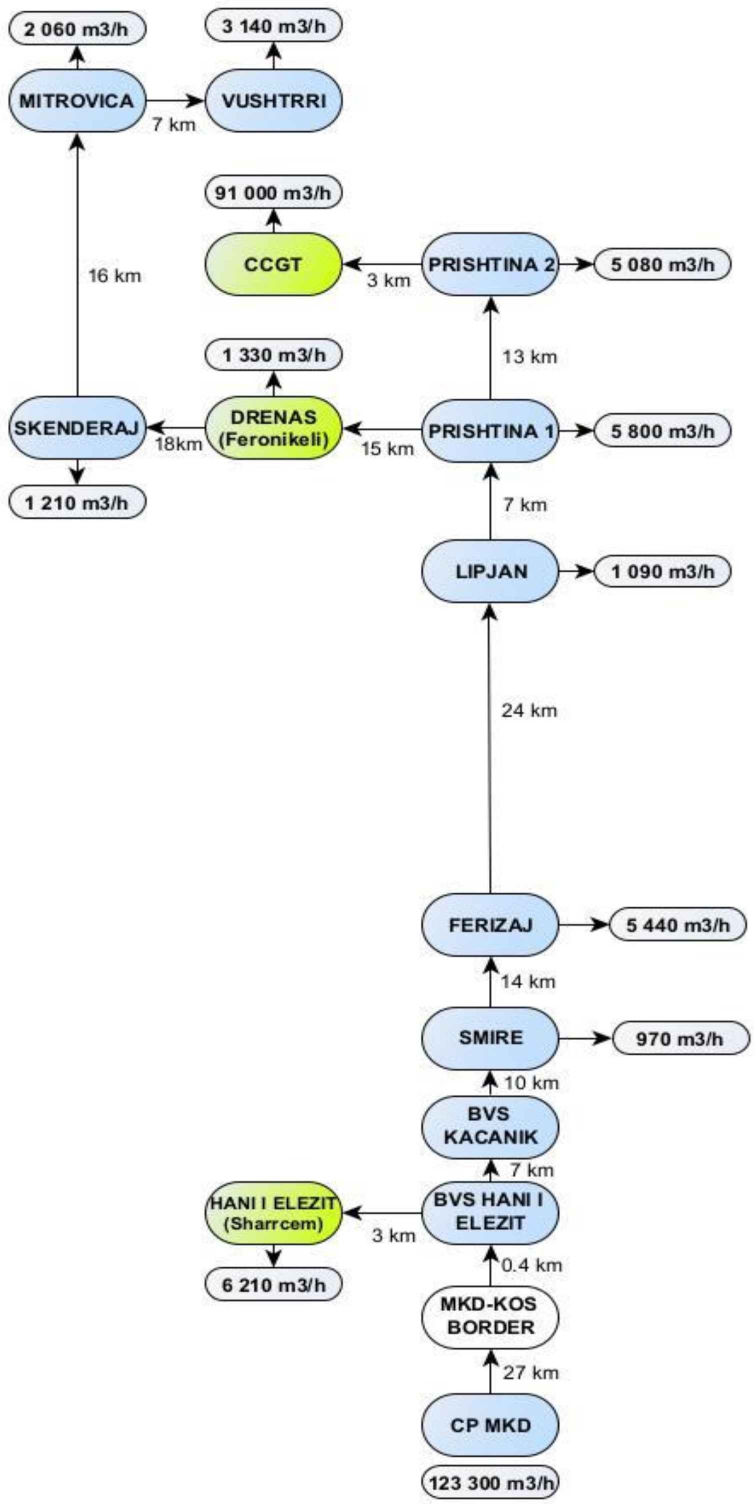


Hydraulic calculation for the industrial gasification scenario

Following figure presents Block Flow diagram for the base industrial gasification scenario.

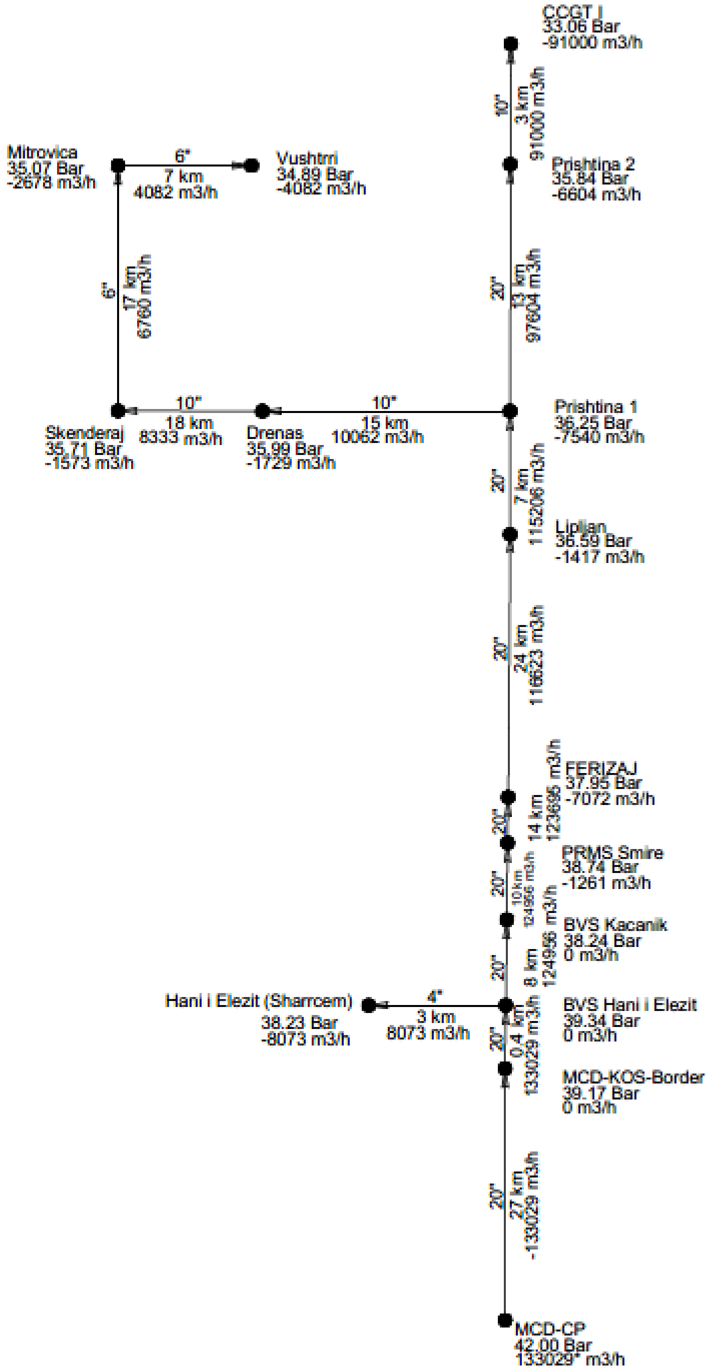
These quantities were increased by 30% for the purpose of hydraulic calculations.

FIGURE 89 – BLOCK FLOW DIAGRAM FOR THE INDUSTRIAL SMALL GASIFICATION SCENARIO



Following figure presents hydraulic model for the industrial gasification scenario.

FIGURE 90 – HYDRAULIC MODEL FOR THE INDUSTRIAL GASIFICATION SCENARIO



ANNEX 2: MAPS

In separate files.

ANNEX 3: PROVISIONAL DISTRIBUTION NETWORKS

Description of the distribution networks development is provided in Chapter **7.3**.

Figures provided herein are for illustrative purpose only. These distribution network layouts have been created with the sole purpose of estimating the potential length of the distribution network and should not be used for other purposes.

FIGURE 91 – DISTRIBUTION NETWORKS OF PRISHTINA, FUSHE KOSOVE, AND OBILIQ

FIGURE 92 – DISTRIBUTION NETWORK OF PRIZREN

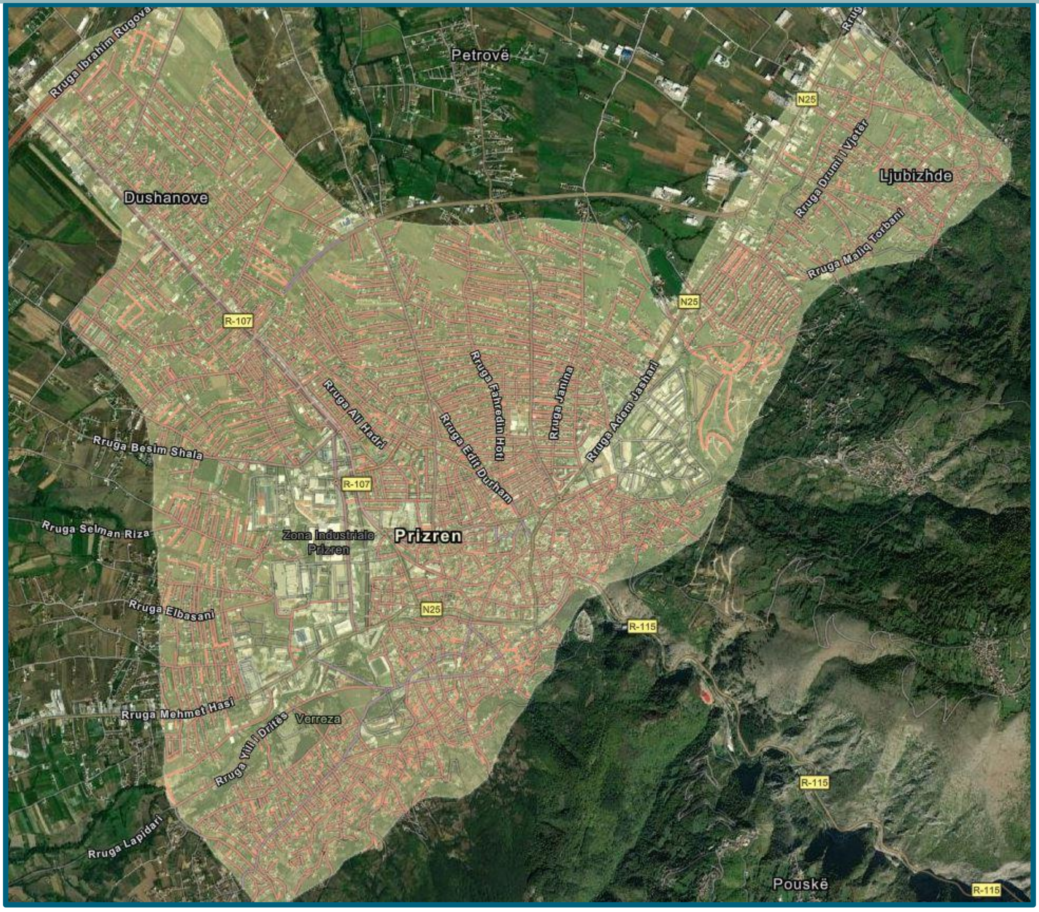


FIGURE 93 – DISTRIBUTION NETWORK OF FERIZAJ

FIGURE 94 – DISTRIBUTION NETWORK OF PEJA

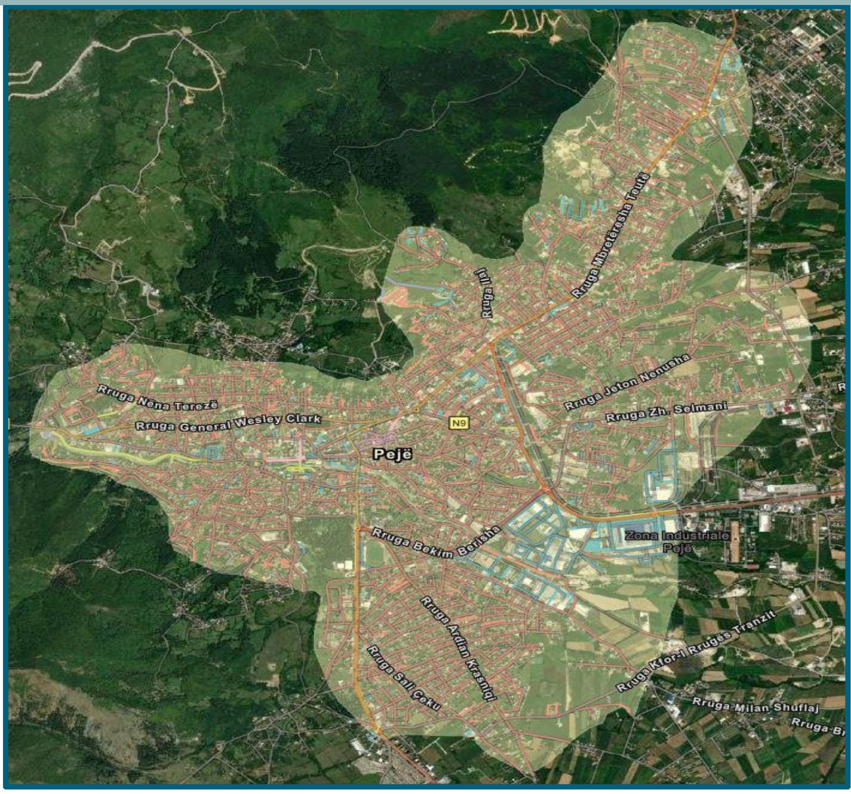


FIGURE 95 – DISTRIBUTION NETWORK OF GJAKOVA

FIGURE 96 – DISTRIBUTION NETWORK OF GJILAN

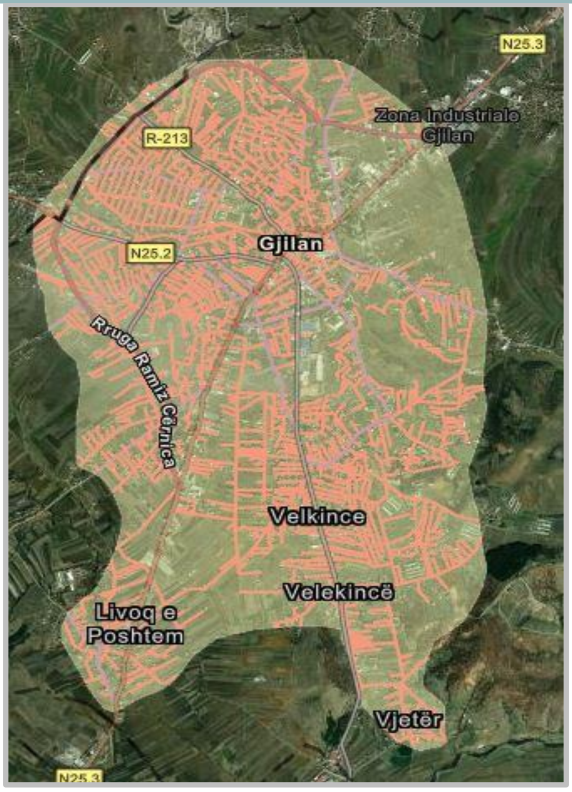


FIGURE 97 – DISTRIBUTION NETWORK OF PODUJEVË

FIGURE 98 – DISTRIBUTION NETWORKS OF MITROVICË AND MITR. E VERIUT (NORTH MITR.)

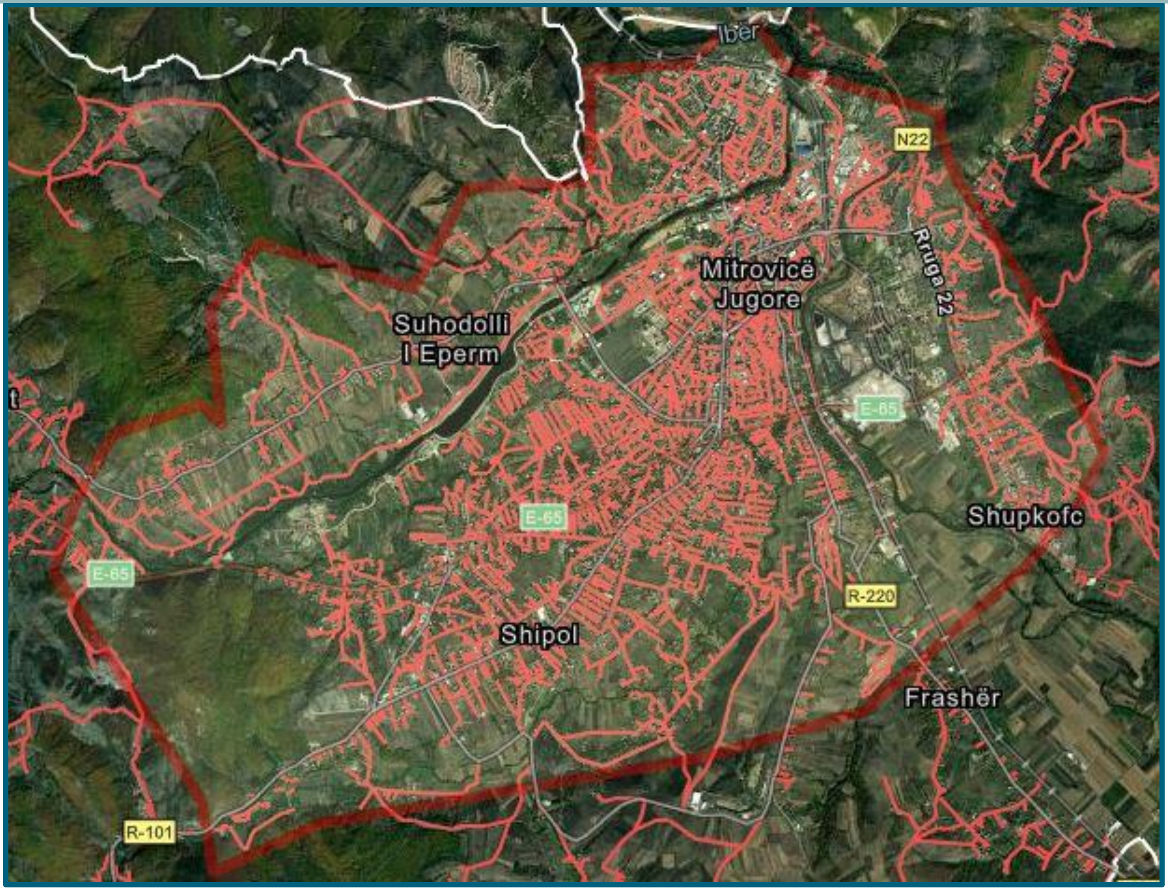


FIGURE 99 – DISTRIBUTION NETWORK OF VUSHTRRI

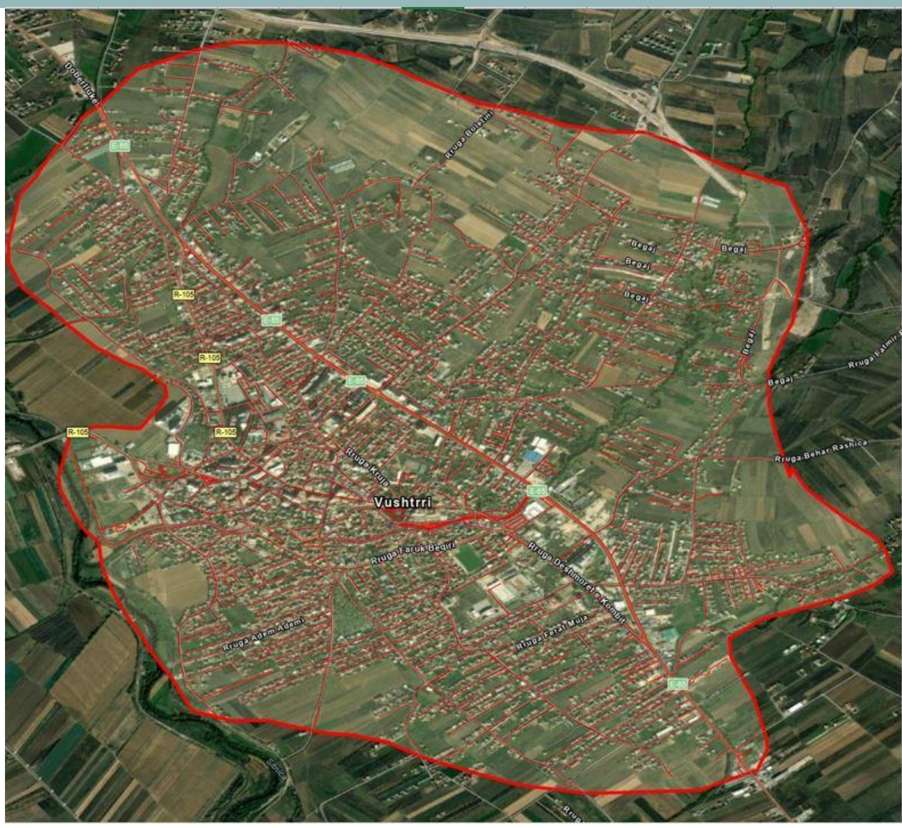


FIGURE 100 – DISTRIBUTION NETWORK OF SUHAREKË

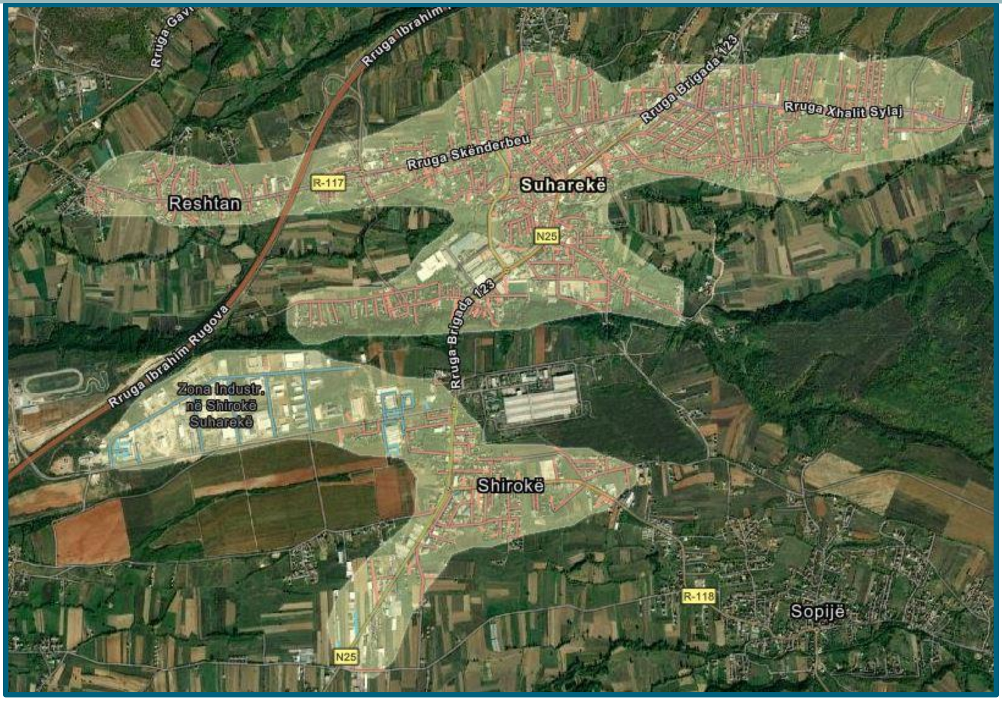


FIGURE 101 – DISTRIBUTION NETWORK OF DRENAS

FIGURE 102 – DISTRIBUTION NETWORKS OF LIPJAN (LEFT) AND RAHOVEC (RIGHT)

FIGURE 103 – DISTRIBUTION NETWORK OF MALISHEVË

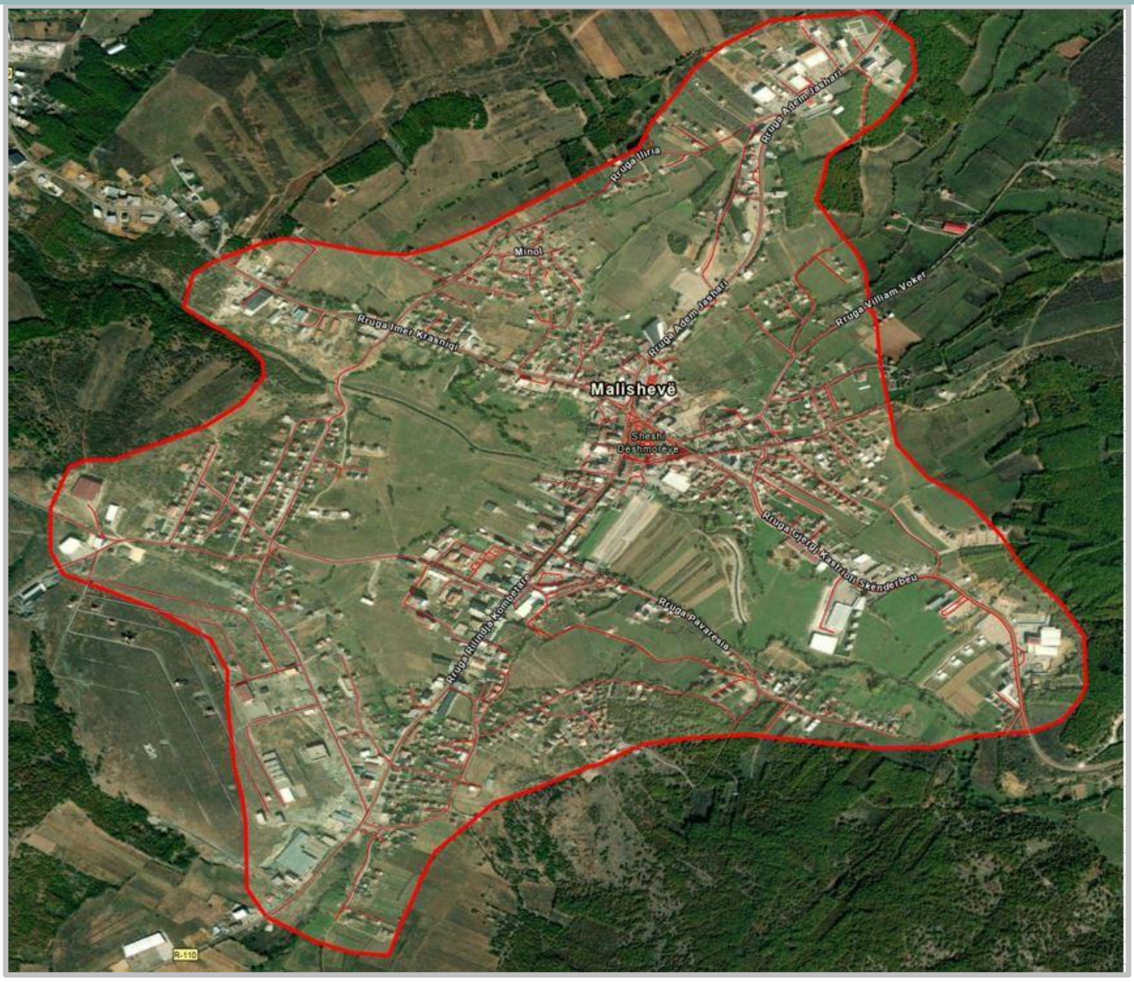


FIGURE 104 – DISTRIBUTION NETWORK OF SKENDERAJ

FIGURE 105 – DISTRIBUTION NETWORK OF VITI

FIGURE 106 – DISTRIBUTION NETWORK OF DEÇAN

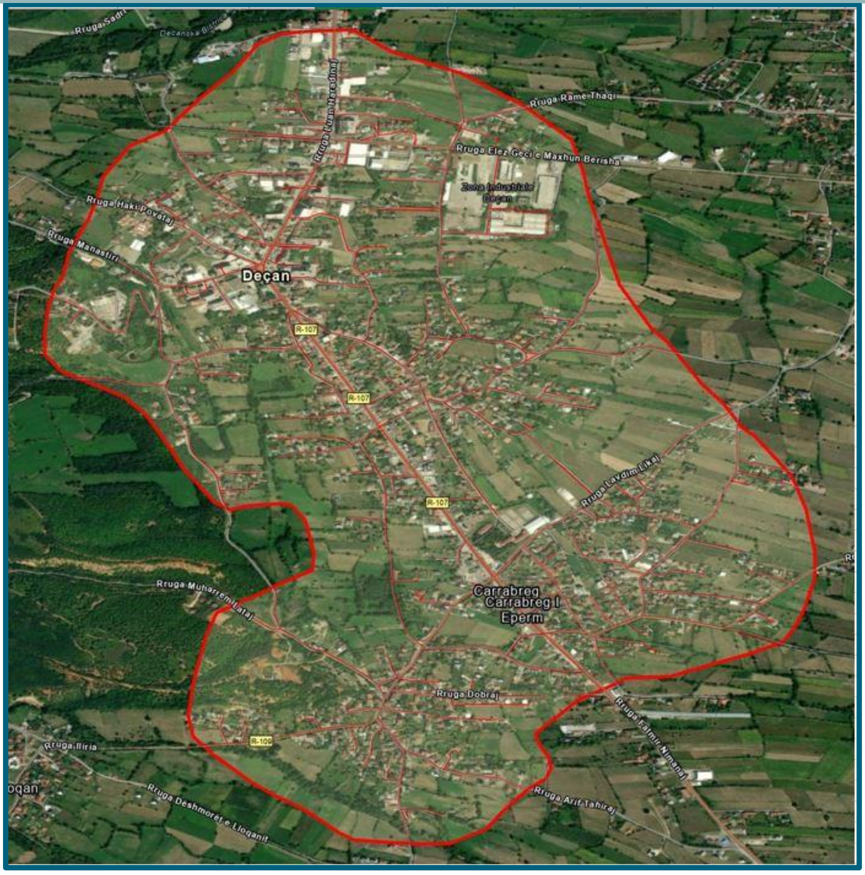


FIGURE 107 – DISTRIBUTION NETWORK OF KLINË

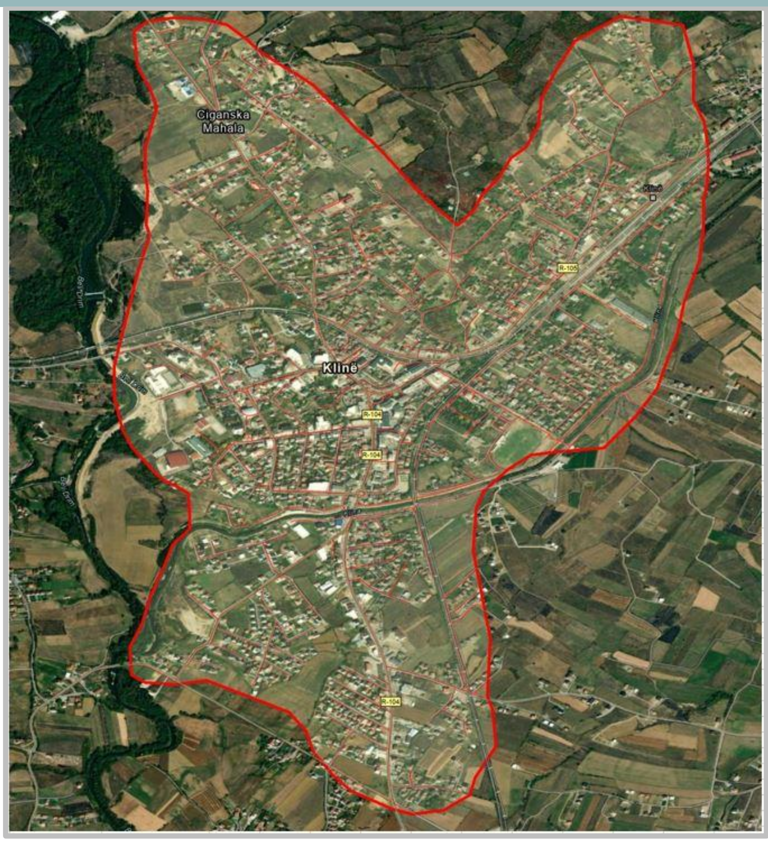


FIGURE 108 – DISTRIBUTION NETWORK OF KAMENICË

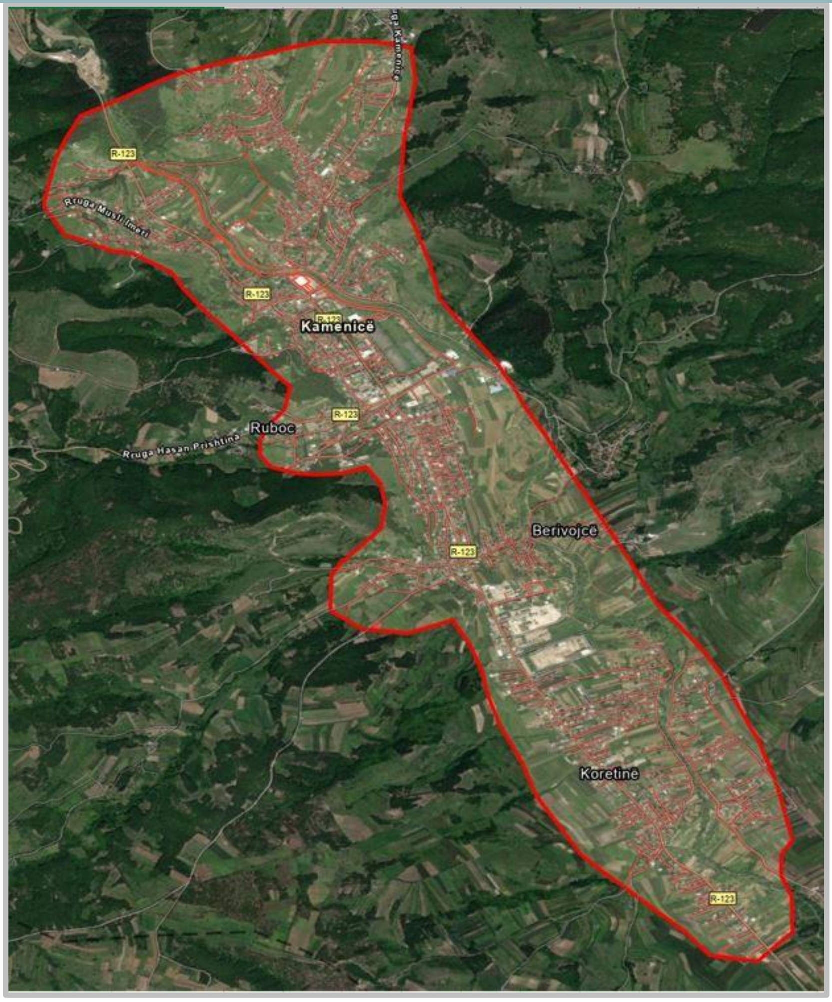


FIGURE 109 – DISTRIBUTION NETWORK OF ISTOG

FIGURE 110 – DISTRIBUTION NETWORK OF DRAGASH

FIGURE 111 – DISTRIBUTION NETWORK OF KAÇANIK

FIGURE 112 – DISTRIBUTION NETWORK OF SHTIME

FIGURE 113 – DISTRIBUTION NETWORKS OF HANI I ELEZIT (LEFT) AND MAMUSHE (RIGHT)

ANNEX 4: SAFETY REQUIREMENTS

When developing gas transmission pipelines special care should be given to the route selection. Route selection shall take into account the design, construction, operation, maintenance and abandonment of the pipeline, and should also take into consideration anticipated urban and industry developments.

Factors that shall be considered during route selection include:

public safety, and safety of the personnel working on or near the pipeline;

environmental protection;

other property and facilities;

third-party activities;

geotechnical, corrosion, and hydrographical conditions;

construction requirements, operation and maintenance requirements ;

national and/or local requirements;

future exploration.

Pipeline materials shall have the mechanical properties, such as strength and toughness, necessary to comply with the design requirements and the requirements for corrosion control. Materials must be suitable for the intended fabrication and/or construction methods.

The technical requirements and standards for the safeguard of people and property and protection of oil and gas pipelines, plants, and equipment that are an integral part of the pipeline system are regulated.

Local regulations (most of which are derived from the international regulations and standards or are taken over from the regulatory framework of former Yugoslavia) and international norms and standards, which are supposed to be implemented in the gas sector in Kosovo, were taken into account.

The following international norms and standards were taken into account for this sector:

EN 14161: Petroleum and natural gas industries – Pipeline transportation systems

EN 1594: Gas supply systems – Pipelines for maximum operating pressure over 16 bar – Functional requirements

EN 1776: Gas supply systems – Natural gas measuring stations - Functional requirements

EN 12186: Gas supply systems – Gas pressure regulating stations for transmission and distribution - Functional requirements

EN 12327: Gas supply systems – Pressure testing, commissioning, and decommissioning procedures - Functional requirements

EN 12583: Gas supply systems – Compressor stations - Functional requirements

AMERICAN / ISO STANDARDS

API 5L:2008 Specification for Line Pipe

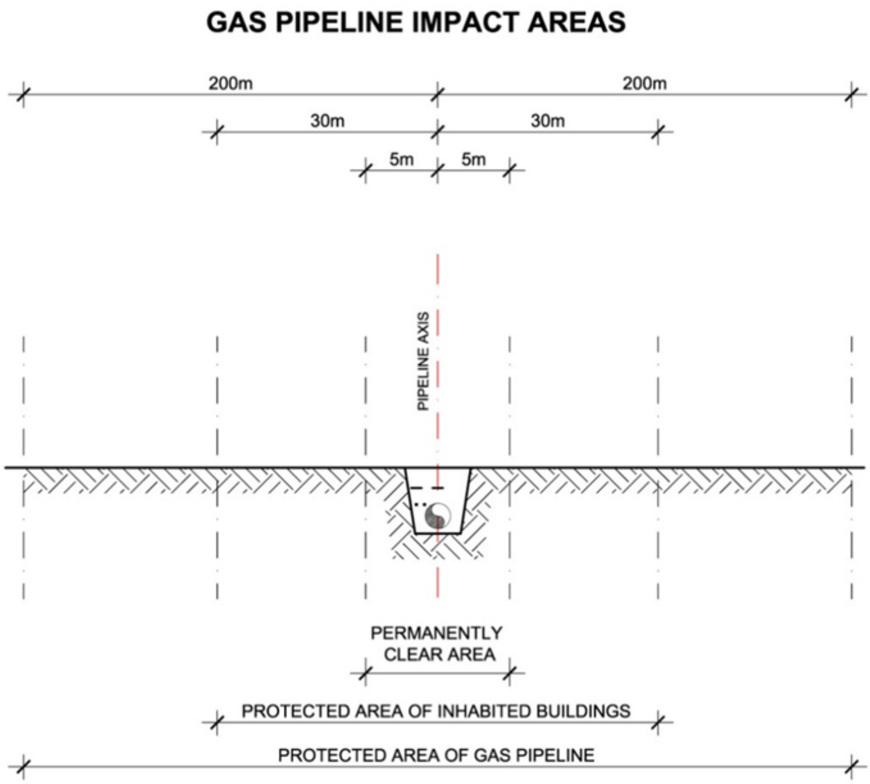
ISO 3183:2007 Petroleum and natural gas industries – Steel pipe for pipeline transportation systems

The regulations define the safety zones of the pipelines. The safety zones for the gas transmission pipelines are presented in **Table 40** and **Figure 114** below:

TABLE 40 – SAFETY ZONES OF THE PIPELINES

Zone	Scope	Description
Priority safety zone 5 m	5 meters on each side of the pipeline axis	It's forbidden to plant plants with roots longer than 1 meter or plants that are cultivated by digging more than 0,5 meters
Protected zone 30 m	30 meters on each side of the pipeline axis	It is forbidden to build housing objects in the future
Wider safety zone / Protected area 200 m	200 meters on each side of the pipeline axis	Based on the level of population density, additional protection measures should be undertaken

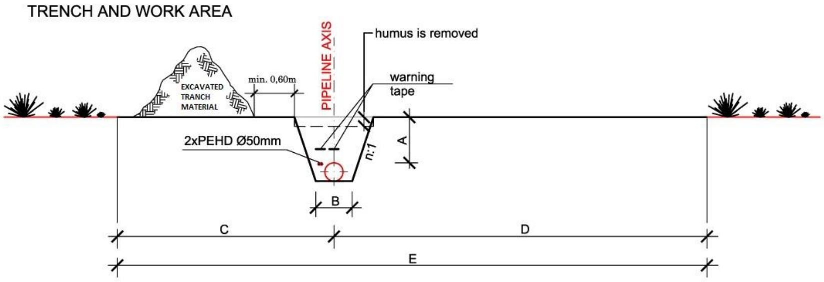
FIGURE 114 – GAS PIPELINE IMPACT AREAS



The pipeline working areas depend on the pipeline diameter, as shown in **Figure 115** below, and the type of the area. To protect the forests the working areas in the forests are narrower in comparison to the open fields and arable lands.

FIGURE 115 – TRENCH AND WORK AREA

TRENCH AND WORK AREA



NOMINAL DIAMETER PIPE INCH	DN mm	A (MIN.) METERS NORMAL SOIL		A (MIN.) METERS COMPACT ROCK		B (m) NOR. SOIL OR COMP.ROCK	C (m) WORK AREA	D (m) WORK AREA	E (m) WORK AREA
4"	100	LOCATION CATEGORY 1 : 1 m	LOCATION CATEGORY 2, 3, i 4 : 1 m	LOCATION CATEGORY 1 : 0,5 m	LOCATION CATEGORY 2, 3, i 4 : 0,65 m	0,40			
4"	150					0,45	3	9	12
8"	200					0,50			
10"	250					0,60			
12"	300					0,70	4	10	14
14"	350					0,75			
16"	400					0,80			
18"	450					0,90	5	11	16
20"	500					1,00			
22"	550					1,00			
24"	600					1,00			
26"	650					1,20	6	12	18
28"	700					1,20			
30"	750					1,30			
32"	800					1,30	7	13	20
34"	850					1,40			
36"	900					1,40			
40"	1000					1,50	7	13	20

LEGEND:

A -minimum overlay material above gas pipelines
B -trench bottom width
C -area intended for the disposal of dredged material and eventually removed humus
D -area for assembly - welding, vehicle and machinery movement
E -total work area width

NOTES:

- trench bottom is flat; sides are slanted depending on quality type
- trench bottom and sides must be without rock and other hard materials that may damage isolation
- excavated soil should not be mixed with other admixtures
- humus is removed on arable areas only above the trench and deposited of separately along with excavation material

Similarly, safety zones are prescribed for the above ground pipeline structures: block valve stations, pig trap stations, gas pressure reduction, and metering stations and compressor stations:

Distance of block valve stations or pig trap stations from the edge of roads or railway tracks must be greater than 30 m.

Distance of compressor station from neighbouring buildings must be greater than 100 m or from the edge of roads or railway tracks must be greater than 30 m.

Distance of pressure metering station from neighbouring buildings must be greater than 15 m for solid object metering stations or greater than 30 m for open space pressure metering stations

The wall thickness of pipelines must withstand all internal and external loads to which the pipeline is exposed. Safety factors must be taken into the calculation of pipeline wall thickness and depend on the population and building density in the 400 m wide protected area of the pipeline:

1st zone – a stretch of the pipeline where there is less than six apartment buildings lower than four floors - 1,4

2nd zone - a stretch of the pipeline where there is more than six and less than twenty eight apartment buildings lower than four floors - 1,7

3rd zone - a stretch of the pipeline where there is more than twenty eight apartment buildings lower than four floors, or where there are commercial, industrial, service, educational, health, and other buildings and public areas such as playgrounds, walkways, recreation areas, open stage, sports fields, fairgrounds, parks and similar areas where more than twenty people permanently or temporary resides, and are situated at a distance of 100 m from the axis of the pipeline - 2,0

4th zone - a stretch of the pipeline where there are predominantly apartment buildings higher than the four floors - 2,5

The above mentioned safety factors are increased if the pipeline passes under roads, railroads, or similar.

The minimal distance from the pipeline and some of the objects that could be located in the pipeline development corridor is also regulated, usually:

More than 5 m from the outer side of road zone/for regional and local road

More than 10 m from the outer side of road zone/for 1 level roads

More than 20 m from the outer side of road zone/for high ways and outer side of train zone/for railways

More than 1 m horizontally from construction objects/from the base of the object, with condition that stability is not under threat.

More than 50 cm from other installations

More than 10 m from regulated water systems and channels.

Above mentioned distances will be confirmed or new ones will be required by the relevant authorities during the permitting procedure. Each relevant authority will issue conditions related to the layout of the pipeline and infrastructure they are responsible for.

The pipeline will be buried along the entire length of the route to the minimum depth, which depends on the type of soil through which the pipeline passes:

in clay soil: at least 1 m measured from the top of the gas pipeline (soil excavation categories I-III);

in stone soil: at least 0,7 m measured from the top of the gas pipe (soil excavation categories IV-VI).

Minimal burying depth also depends on the pipeline zone. For zone IV minimal burying depth should be at least 1,1 m or should be bigger if the pipeline passes below transport facilities, rivers, or similar.

Burying depth can deviate from the above mentioned, i.e. it may be even higher if such special conditions for the construction are prescribed during the location permit procedure.

Burying depths are greater when the pipeline passes through the protected zone of buildings (total zone width of 60 m):

in clay soil: at least 2 m measured from the upper edge of the gas pipeline (soil excavation categories I-III);

in stone soil: at least 1,5 m measured from the upper edge of the gas pipeline (soil excavation categories IV-VI).

The pipeline must be equipped with shut-off elements located and spaced in such a way that the distance from any point of the pipeline to the nearest shut-off device for a specific pipeline building zone is maximal:

1st zone – 16 km

2nd zone – 12 km

3rd zone – 6 km

4th zone – 4 km

All parts of the pipeline must be protected from corrosion. Above-ground parts of the pipeline, which are not galvanized, shall be protected by anti-corrosion coatings that must be applied in accordance with the provisions of the technical measures and conditions for the protection of steel structures from corrosion.

Corrosion protection of underground pipelines should consist of passive protection (insulation) and active protection (cathodic protection).

Examination of welds in the pipeline and primary piping shall be performed before pressure testing in accordance with ISO 13847.

Welds should be examined as follows:

all welds shall be visually examined

a minimum of 10% of the welds completed each day shall be randomly selected for examination by radiography or ultrasonic. The examination shall be increased to 100% of the welds if lack of weld quality is indicated, but may subsequently be reduced progressively to the prescribed minimum percentage if a consistent weld quality is demonstrated.

100% of the welds shall be examined by radiography or ultrasonic for special conditions like pipelines within populated areas, transport and river crossings, and similar.

Pipelines and primary piping shall be pressure-tested in place after installation but before being put into operation to demonstrate their strength and leak-tightness. Prefabricated assemblies and tie-in sections may be pretested before installation provided their integrity is not impaired during subsequent construction or installation. Minimum test overpressure should be 25% - 50% higher than calculated overpressure for the pipelines depending on the pipeline safety coefficient or zone or depending on the type of system equipment.

The route of the pipeline must be clearly marked with special marks. The distance between the marks must not be greater than 1.000 m on the flat part of the route. At the curved portion of the pipeline route, markings are placed at the beginning, in the middle, and at the end of the bend.

Marks of the pipeline route are placed at 0,8 m to the right of the flow direction of the media. Marks should be placed on both sides of the watercourse-, road- and similar crossings.

General Requirements

The transmission pipeline routes are located outside populated areas and protected areas. Wherever it is possible, a safety distance of 30 m from the existing dwellings is provided.

The routes were analysed from the technical and economic aspects in order to be compatible with the other urban and infrastructural elements of the area.

The following general recommendations should be taken into account during the detailed design stage when a refined pipeline alignment is selected:

Future development plans for industrial activity areas should be taken into account and consultations should take place with affected stakeholders.

“Good routing practice” should be followed with respect to the impact on land and/or owners. The pipeline route should avoid or minimise passing through densely forested areas. Generally, the detailed routing should try to keep the impact on the land to a minimum, using gaps in forested areas and minimising the number of disturbances to arable land.

Sharp angle crossings should be avoided. Crossing angles should always be kept as close to the right angle as possible.

The detailed alignment should minimise the pipeline bends by eliminating unnecessary Intersection Points (IP’s).

Proximity to existing buildings should be avoided in order to keep the heavy pipe wall requirements to a minimum.

Environmental concerns need to be taken into account and any environmental impacts should be minimised to acceptable levels.

ANNEX 5: PIPELINE LAYING, CONSTRUCTION REQUIREMENTS AND CONSTRUCTION METHODS

Pipe laying and construction requirements

The pipelines are buried in the ground with minimal required cover. The minimal cover requirements are based upon pipeline location class and terrain types as prescribed by applicable laws and regulations (see Safety Requirements).

The depth of cover must be below the freezing depth as well.

This is important in order to avoid freezing of ground water around the pipeline, which can damage the insulation. To access the pipeline route and the facilities, existing roads will be used predominantly with the approval of the competent authorities. It is necessary to build only local access to pipeline facilities, which reduces required construction costs and the environmental impact.

To dig a trench for laying a gas pipeline, it is necessary to provide a work area, often referred to as right-of-way. The width of that work area is determined in principle, depending on the diameter of the gas pipe and other regional and organizational conditions. For the minimal pipeline work area requirements see **Figure 115**. When the cross slopes are greater than 10% (or 10°) work area expands due to cuts and embankments. It is important by it that trench must always be excavated in the homogeneous ground.

It is often necessary to provide space for the deposition of humus, which is after pipeline backfilling to be returned to its original place.

Gas pipeline trench

Pipeline trench excavation is carried out mechanically and manually depending on existing facilities on the route and terrain conditions, with mandatory manual excavation in the zones of the existing underground installations.

Required trench width at the bottom depends on pipeline diameter.

Excavation for the gas pipeline in the different soils (materials of different excavation categories) is to be carried out with proper mechanical equipment.

Excavation and fine diggings of trenches in loose soft soil, such as soft ground, pure sand, loose gravel, humus, sand clay, sandy clay, compacted sand and fine gravel, and similar soil are performed without the use of explosives.

Taking into consideration the gas pipeline diameter, and consequently depth of the trench, excavation is carried out so that lateral sides are sloped. As the trench is not too deep, and the trench sides are properly sloped, no planking and strutting of the lateral sides of the trench are foreseen as necessary. This can significantly change at the locations of crossings.

The bottom of the trench must be aligned, planned, without stone impurities that can damage the pipe insulation. Where the ground water is high or the terrain prone to flooding, the contractor will dig a trench in harsh conditions. In such cases, the most effective work can be done in the dry season, or by pumping water out of the trench.

Trench backfilling is done with proper mechanical equipment by laying pipes onto a 15 cm tick sand bed layer, and then covering the pipe in sand up to 15 cm above the top of the pipe. In case that the excavation material is sandy or loose to the extent that it does not damage the pipes and pipe coating during the backfilling, there is no need to use sand in the trench. The rest of the trench is backfilled with the material from the excavation.

A protective yellow band with the inscription 'DANGER GAS PIPELINE' is incorporated into the trench at the required distance above the pipe. The tape is placed along the whole length of the gas pipeline except at the places of drilling under roads and waterways.

In sections with a longitudinal inclination of the gas pipeline greater than 20%, it is foreseen that anti-erosion barriers should be set up, made from bags filled with a mixture of sand and cement in order to prevent washing off of the soil.

Protection of the gas pipelines from mechanical damage in sections of rocky and broken stone terrain is foreseen to be carried out by laying the gas pipeline on sandbags placed previously at the bottom of the trench, whereupon the gas pipeline is covered with soft earth or sand 0.3 m above the pipe or the sandbag layer as well.

<u>Pipe laying and bending</u>

The pipelines will be constructed from approximately 14 to 18 m long pre-insulated steel pipes.

The pipes will be transported with vehicles suitable for pipe transportation to the pipeline construction site and positioned along the work area. The pipes will be unloaded with a mounted pipe-layer crane, and side boom, and placed end-to-end alongside the future trench, taking special care not to damage the pipes.

Where the pipeline route changes direction or if there are significant changes in the natural ground contours, hydraulic bending machines shall be used for gradual cold pipe bending. This equipment bends individual pipes to the desired angle. Where the bend cannot be made to meet specific requirements, a prefabricated factory bend will be used.

<u>Welding</u>

Pipes will be connected and welded together so that a pipe section is formed and placed on temporary supports along the edge of the trench. After laying pipe sections in the trench the individual pipe sections will be welded together to form the pipeline. Appropriate welding procedures shall be used.

Welds should be examined as described in (see Safety Requirements).

Protection against corrosion

After the welds have been checked, tested, and approved the exposed steel section at the joint between the pipes, will be cleaned, sand-blasted, and protected by applying a protective coating to it (e.g. heat-shrinkable polyethylene sleeves around the pipe). The pipeline will be examined for coating damage after installation. The entire pipeline coating will be electronically inspected, using Direct Current Voltage Gradient (DCVG) or any equivalent technique. Before the pipe section is laid on the bottom of the trench, the insulation will be re-tested.

Above-ground parts of pipelines shall be protected by a protective paint system.

Beside passive mechanical anticorrosion protection, the pipelines will be protected by active cathodic protection and protection from stray currents.

<u>Hydrostatic testing</u>

The entire installation needs to be tested for strength and tightness before it is used. The most common method for testing the integrity of the pipeline and checking for any potential leaks is hydrostatic testing. It is performed by filling the pipeline with water and keeping it under a certain pressure to check that the pipeline is not damaged and will not leak during operation. The minimum testing pressure in the pipeline for strength test has to be greater than the maximum working pressure. The final test of the installation is performed after the pipeline has been laid into the trench and backfilled.

Monitoring and control of the process, and optical communication system

Monitoring and control include collecting data from the blocking electronic devices (Electronic Line Break Control - ELBC) and other equipment for monitoring and control, and data transfer to the Dispatch Centre (DC). All facilities are linked to the system of remote monitoring and control of the gas network.

The monitoring and control equipment will be installed in a container within the facility. The container must be placed outside the hazardous area, which is defined in regard to the potential for an explosive atmosphere (Ex zone). The container must ensure appropriate conditions of temperature and humidity (air conditioning, heating, room temperature 15 ° to 25 ° C, and forced ventilation).

Data transfer and Communication to the DC is provided with an optical cable. Along the entire route of the gas pipelines, two 50 mm HDPE pipes can be installed (one active, one spare) for the light-wire signal cable.

Construction methods

The proposed construction methods are described below, including the techniques that will be used to cross roads, railroads, and watercourses.

Typically, where there are no other specific requirements, onshore pipeline construction is a sequential process including several distinct operations, and is called:

Spread Technique

The "spread" method of construction for onshore pipelines is normally employed and involves several groups of construction personnel and equipment that collectively conduct the various stages of the construction operation. Each group of personnel and equipment completes an activity, which picks up where the last one left off, advancing the construction process a step at a time and leaving it ready for the next step to begin. Depending on the timescale for construction, it may be necessary to have multiple spreads working at different locations.

A typical pipeline construction spread will be as follows:

Route surveying, preparation of the work area, top soil stripping and grading. This activity prepares a continuous running track for the pipeline construction crews.

Pipe bending and stringing. This involves transporting the line pipes from the pipe dump to the spread and placing them on skids in a continuous string ready to be welded.

Welding. The individual line pipes are joined into a continuous pipeline string.

Non Destructive Testing (NDT) usually carried out by radiography.

Field Joint Coating and checking the pipeline coating for defects

Trenching.

Lowering the pipeline string into the trench.

Backfilling.

Hydrostatic Testing

Dewatering then drying of the pipeline. This can be followed by nitrogen purging if the commissioning does not shortly follow the drying operation. The purpose of nitrogen purging is to create a non-corrosive atmosphere within the gas pipeline and prevent the occurrence of an explosive mixture of gas and air by the initial release of the gas into the pipeline.

Coating and corrosion protection surveys to ensure that the corrosion protection system works properly and that there are no major defects in the coating.

Site clean-up and reinstatement. In agricultural land, this involves returning the work area to its original condition and re-seeding it.

In addition to the spread team(s), specialist teams will be set up as required to undertake work associated with road, railroad, and river crossings and other sections of constricted working, as well as to construct sections through any stretches of particular sensitivity, including conservation areas. In these sections of particularly sensitive environments, modifications are generally made to the standard spread technique aiming to eliminate avoidable environmental damage.

Final construction methods will be determined during the detailed design.

Open-cut Crossings of roads, railroads, and watercourses

Open-cutting a crossing is similar to standard pipeline construction but with a greater depth of cover and, where needed, with the installation of concrete slab protection on top of the pipeline. This is normally followed by reinstating the crossing to its original condition.

Open cut crossings are cheaper to construct than trenchless methods and they are therefore used where pipeline construction is not going to have a significant negative impact on the traffic or the environment.

Auger Boring

Auger boring is a trenchless technique for crossing beneath roads, railroads, or watercourses and because of the use of specialized equipment has higher initial construction costs than traditional open-cutting. However, taking into account the disruption that the open-cut method causes to traffic or the environment, auger boring becomes the preferred option. It is also a requirement of the highway authorities in most countries that all major road crossings and important watercourses are to be constructed by trenchless techniques. Thus, for all asphalt roads of higher rank or higher traffic load (regional, major, state), a boring method is foreseen.

Auger boring provides a safe method of installing pipes and cables while supporting the ground during the bore.

Auger boring is to be carried out by installing a steel casing pipe from a drive pit through the ground while removing the soil inside the encasement by means of the continuous flights (contained within a steel casing pipe) which are rotated and simultaneously pushed into the ground. The casing supports the soil around it as the bore progresses, the ground is cut and the auger flights convey the material back into the work pit. After installation of the casing, a product pipe is installed and the remaining annular space is filled with grout or kept empty and provided with vents. To avoid problems with the pipeline cathodic protection, steel casing pipe can also be included in the cathodic protection system. The installation of the casing is often required by the local regulations and standards.

A typical maximum length of an auger bore is approximately 80 m to 100 m.

Pipe Jacking

Pipe jacking involves installing a sleeve, normally made of prefabricated concrete pipe sections, under the crossed feature and then installing the pipeline inside the sleeve. In this method, new pipe sections are jacked from a drive shaft or pit so that the complete string of pipe is installed simultaneously with the excavation. The pipe jacking technique requires workers inside the borehole during excavation and sleeve installation and therefore the sleeve needs to be sufficiently large for man entry. Pipe jacking is more expensive than auger boring but allows for longer crossing lengths so it is usually recommended for crossing lengths between 100 m and 150 m.

Horizontal Directional Drilling (HDD)

Horizontal directional drilling is a trenchless construction method utilizing equipment and techniques from horizontal oil well drilling technology and conventional road boring. HDD construction is used to install gas pipelines where conventional open trench construction is not feasible or will cause adverse disturbances to the environment, land use, or physical obstacles, or the crossing is too long for an auger bore or a pipe jack.

Directional crossings have the least environmental impact of any alternate method. The technology also offers a maximum depth of cover under the obstacle thereby affording maximum protection and minimizing maintenance costs. HDD installation involves three main steps: drilling a pilot hole, expanding the pilot hole by reaming, and pulling back of pre-fabricated product pipeline section.

An HDD drill rig and supporting equipment are set-up at the drill entry location determined during the pre-site planning phase. A pilot hole is drilled beginning at a designed angle from horizontal and continues below the obstacle along a designed profile consisting of straight tangents and long radius arcs.

Drilling fluid is injected under pressure ahead of the drill head to transport drill cuttings to the surface, clean build-up on the drill bit, cool the drill bit, reduce the friction between the drill and bore wall, and stabilize the borehole.

Once the pilot hole is complete, the hole is enlarged to a suitable diameter for the product pipeline. The number of reaming passes is determined by the hardness of the material being reamed and the ability to remove cuttings from the hole.

Geology - geographical conditions are critical for this construction method, depending on which, crossing lengths up to 2 km can be achieved.

Based on the proposed routes, their characteristics, technological and technical requirements, and methods of construction, the investment costs were determined.

Transmission system advanced technologies considerations

<u>Methane fugitive emissions</u>

Methane emissions from oil and natural gas, including all emissions from exploration, production, processing, transport, and handling of oil and natural gas (excluding utilisation) account for 1,3% of the total greenhouse gases (GHG) emissions in the European Economic Area (EEA). In the period from 1990 to 2016, the EEA reported a 38% decrease of GHG emissions in these sectors, mainly due to the reduction of methane emissions from natural gas activities. Methane emissions from gas operations represented 6% of the total EU methane emissions, equivalent to 0,6% of the total EU GHG emissions. In the same period, gas consumption increased by 25% (from 360 to 449 bcm). The length of the gas network increased as well.

Today, a large number of best available techniques (BAT) in the field of detection, quantification, and mitigation of methane emissions are already in place across the gas value chain, implemented by the gas industry on a voluntary basis. Those will be incorporated in the future natural gas pipelines on the Kosovo territory.

The methane emission reduction BATs are related to engineering design, commissioning, operation, including maintenance and repairs, and decommissioning. Examples of BAT in transmission are [10]:

Activities in the design phase:

- Eliminate Unnecessary Equipment and/or Systems (to minimise equipment leaks in Metering and Pressure Regulating Stations)

Activities during operation and maintenance which will be enabled by appropriate design solutions:

Recover Gas from Pipeline Pigging Operations (to minimise vented emissions during Blow and Purge)

Using Pipeline Pump-Down Techniques to Lower Gas Line Pressure before Maintenance - Recompression instead venting (to minimise vented emissions during Blow and Purge)

Activities during operation and maintenance:

Test and Repair Pressure Safety Valves (to minimise equipment leaks in Metering and Pressure Regulating Stations)

Composite Wrap for Non-Leaking Pipeline Defects (to minimise vented emissions during Blow and Purge)

Perform Valve Leak Repair during Pipeline Replacement (to minimise equipment leaks in Metering and Pressure Regulating Stations)

Using Hot Taps for In Service Pipeline Connections (to minimise vented emissions during Blow and Purge)

Use Inert Gases and Pigs to Perform Pipeline Purges (to minimise vented emissions during Blow and Purge)

Inject Blowdown Gas into Low Pressure Mains or Fuel Gas System (to minimise vented emissions during Blow and Purge)

Reduce Frequency of Replacing Modules in Turbine Meters (to minimise equipment leaks in Metering and Pressure Regulating Stations)

Increase Walking Survey from a 5- to 3-Year Basis (to minimise Underground Pipeline Leaks)

Implement minimising vents programmes (to minimise equipment leaks in Metering and Pressure Regulating Stations)

Leak Detection and Repair (LDAR) programmes (to minimise Equipment and underground pipeline leaks).

LDAR programmes to reduce fugitive emissions

LDAR (Leak Detection and Repair) regulations were put into place in an effort to reduce fugitive emissions because of the amount of VOCs (Volatile Organic Compounds - including methane) being emitted by industry. The gas industry implemented LDAR in order to ensure good performance, to increase safety due to environmental aspects.

A LDAR programme [1] is the system of procedures used to identify and repair leaking components, in order to minimise methane emissions. It normally includes:

Scheduling or systematic inspections;

Producing and tracking work orders when leaking components are discovered;

Training of personnel, who should be aware of the importance of emissions reduction;

Procedures for identifying leaking equipment, procedures for repairing and keeping track of leaking equipment;

Methods of verification which ensure that the LDAR programme is correctly conducted

A typical LDAR approach consists of 5 phases:

1. Inventory of fugitive emission sources at the facility:

Analysis of technical documentation of the facility (P&IDs, process diagrams, parameters, etc.);

Identification of potentially leaking elements at the facility (valves, connectors, open ended lines, flanges, pumps, compressors, etc.);

Planning of the field activities (i.e. integrating LDAR process in maintenance activity).

2. Definition of leaks:

Determination of a threshold limit value of methane. A leak is detected whenever the measured concentration of methane in the surrounding environment exceeds the leak definition. The threshold limit value may be set differently for individual elements.

3. Measurement programme

On-site monitoring and detection of methane leaks;

Detection of leaks according to leak definition;

Identification of emission sources;

Emission estimation, according to the concentration measured and equation of correlation or emissions measurement if appropriate measurement devices are available;

Classification of the leaks.

4. Maintenance and repair

Immediate repair of leaking elements wherever it is possible;

Development of the maintenance/repair plan;

Cost-effectiveness evaluation;

Prioritisation of the interventions;

Periodic checks.

5. Follow-up and traceability

Database implementation with a clear identification of the leaking elements, instruments used, the date the leak was detected, the date the leak was repaired, the results of monitoring tests to determine if the repair was successful, and any further actions

The potential implementation of technologies and practices to cut methane emissions can reduce strategic and operational risk and demonstrate their commitment to the environment.

Distribution system advanced technologies considerations

Smart metering

The transmission pipelines and distribution networks provided in this report will be completely new, built from high quality polyethylene pipes or steel pipes protected by cathodic protection. The quality control of materials and works is required, and provisions are made to take all protective measures.

The only losses are non-technical and may occur due to different readings of the meters at the entry points from the transmission system to the distribution network (PRMS), as opposed to the meters on the distribution network (household connections).

Namely, the volume of gas is naturally dependent on the temperature and geodetic and atmospheric pressure. A high-flow, high-pressure application such as pressure reduction and metering station uses meters that have electronic correction of the factors mentioned above, meeting required EN criteria (for example ultrasonic meters, turbine meters.)

On the other hand, for household connections conventional diaphragm gas meters are commonly used. Their readings are temperature and elevation dependent which requires a calculation of the correction (using the average annual values of temperature, air pressure, and altitude). The allowed deviation of a gas meter accuracy is regulated and depends on the installation, use, and maintenance. Nevertheless, these inaccuracies in the measurement are naturally transmitted on the billing of gas consumption.

TABLE 41 – GAS METERS

Conventional diaphragm gas meter	Ultrasonic Gas Meter	Smart gas meter
		

Ultrasonic gas meters have been in use in the industry for a long time and their application has proven their measurement accuracy. As they do not have moving parts, their accuracy does not change over the years, which greatly reduces gas losses due to measurement errors caused by material wear.

Smart meters are digital devices that record energy consumption at frequent intervals. As opposed to conventional meters, they support additional services, which can be remotely controlled and are fully automated. They are intended for installation across large supply areas.

The main advantages of smart metering are:

Accurate remote reading which benefits a distribution system operator (increased efficiency in meter reading, billing, and the interruption or restoration of service)

Availability of accurate, real-time consumption data which benefits suppliers allowing them to offer new services

Local in home display which benefits consumers through the availability of more precise and timely information on actual energy use.

The gas directive introduced as part of the *3rd energy package* [11] provides for "the implementation of intelligent metering systems to assist the active participation of consumers in the gas supply market". Consumers are to be "properly informed of actual gas consumption and costs frequently enough to enable them to regulate their own gas consumption".

So, for the reasons of energy efficiency, particularly the need to reduce carbon emissions the use of smart metering systems is encouraged by EC.

The problems that have so far been identified in the pilot projects are mainly related to different application of communication standards, complex installation and maintenance of devices, numerous regulations that require additional training of staff, a lot of data, and there is also the issue of privacy of individuals or companies.

Smart gas grid

It is envisaged that, in the coming decades, different types of energy will be distributed through networks capable of managing and regulating multiple, discontinuous and bidirectional flows instantly. A combination of smart metering technology with sensors for smart valves, gas pressure and gas leak detectors, all integrated in the same gas network represent a Smart Gas Grid. Smart Gas Grids allow the gas distribution network to become a tool of the circular economy as recovered waste is used as feedstock for the production of green gases, which are injected into the network. It also optimizes energy costs at the local level through the flexibility that it offers to the electricity grid. In addition, it helps accommodate intermittently available renewable energy sources such as wind and solar energy in the energy mix, thus facilitating the achievement of greenhouse gas reduction targets. [12]

Smart Gas Grid shall:

facilitate the incorporation of green gases in the distribution network;

facilitate integration with electricity, heating, water, and telecommunications networks;

enable active network management and instant information on relevant parameters, both for network operators and market participants;

improve the energy efficiency of the gas grid.

Smart pipes as a component of Smart Gas Grid are based on three key concepts:

Remote surveillance of installations detects any malfunctions and ensures the highest quality service possible.

Remote sensing helps improve flow reconstruction by combining data from the various meters and sensors at key points in the network. Added benefits include improved response in emergencies, optimized investments, and optimized stocks.

Remote control of certain installations will help maximize the injection of renewable gases and allow better balancing between supply and demand.

ANNEX 6: GEOLOGICAL, HYDROGEOLOGICAL, AND GEOTECHNICAL ASSESSMENT

SECTION: Prishtina 1 – Drenas km 0+000-14+600 (14,7 km)

From geomorphological aspect the terrain is from planar to hilly-mountainous (550-700m a.s.l.), from tectonic aspect, the terrain is stable with appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows.

From geological aspect the terrain is composed of young unbound sediments to metamorphosed rock masses such as:

At the subsections km 0+000-3+300, km 10+160-11+500, km 12+000-12+310, km 12+600-13+000, km 13+200-14+150, the terrain is composed of Quaternary and Pliocene sediments, low bound with appearance of groundwater at depth > 3m. There are gravels, sands, sandy clays and clays, with low density, favourable for foundation of linear structures (pipelines etc.). As medium for excavation, they belong to III and IV category according to GN 200.

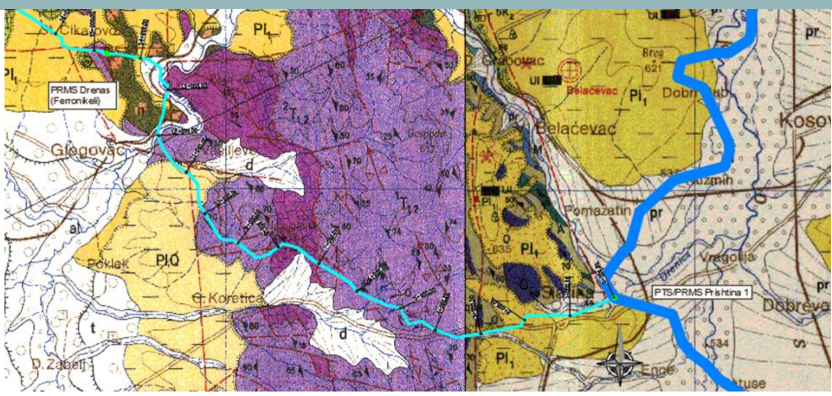
At the subsections km 3+300-10+160, km 11+500-12+000, km 12+310-12+600, km 13+000-13+200, the terrain is composed of Triasic low metamorphosed sandstones, conglomerates and quartzites, low fractured and very strong. As medium for excavation, they belong to V and VI category according to GN 200.

At km 14+150-14+600 the terrain is composed of low metamorphosed serpentine harzburgite, low fractured and very strong. As medium for excavation, they belong to V and VI category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling etc. are less pronounced.

FIGURE 116 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: PRISHTINA 1 - DRENAS

FIGURE 117 – SYNOPTIC GEOLOGICAL MAP, PAGES FERIZAJ AND RAHOVEC, SECTION: PRISHTINA 1 – DRENAS



__SECTION: Drenas - Skenderaj km 14+600- 32+437 (17,7 km)__

From geomorphological aspect the terrain is from planar to hilly-mountainous (550-730m a.s.l.), from tectonic aspect, the terrain is stable with appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows.

From geological aspect the terrain is composed of young unbound sediments to metamorphosed rock masses such as:

At the subsections km 14+600-15+210, km 18+130-18+350, km 19+800-19+850, km 20+400-20+850, km 22+800-23+700 and km 28+750-32+437, the terrain is composed of Triasic and Cretaceous low metamorphosed limestones and limestone breccia and schists, metamorphosed sandstones and claystones, as well as massive limestones, low fractured and very strong. As medium for excavation, they belong to V category according to GN 200.

At the subsections km 15+210-18+130, km 18+350-18+800, km 19+150-19+800, km 19+850-20+400, km 20+850-22+800, km 23+700-28+500 the terrain is composed of Pliocene sediments, represented by clay, marly clay, marls, sand and gravel, low bound, medium to very dense with appearance of groundwater at depth > 5m, favourable foundation medium. As medium for excavation, they belong to IV and V category according to GN 200.

At the subsections km 18+800-19+150 and km 28+500-28+750 the terrain is composed of alluvial unbound sediments, with appearance of groundwater at depth > 3m. There are gravels and sands, with low density, favourable foundation medium. As medium for excavation, they belong to III and IV category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling etc. are less pronounced.

FIGURE 118 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: DRENAS (FERRONIKELI) - SKENDERAJ

FIGURE 119 – SYNOPTIC GEOLOGICAL MAP, PAGES RAHOVEC AND MITROVICA, SECTION: DRENAS (FERRONIKELI) - SKENDERAJ

SECTION: Ferizaj – Suhareke km 0+000-39+600 (39,6 km)

From geomorphological aspect the terrain at km 0+000-14+400 is mainly planar (450-600m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows.

At km 14+400-23+100 the terrain is hilly-mountainous (600-1300m a.s.l.), from tectonic aspect the terrain has many structures such as faults, overthrusts, dykes and other appearances. At this part of the alignment there are low number of intersections with local, regional and mountainous roads, as well as flows.

At km 23+100-31+930 from tectonic aspect the terrain is stable without appearance of tectonic structures (faults, overthrusts, synclines etc.).

At km 31+930-39+600 the terrain is mainly planar (450-600m a.s.l.), from tectonic aspect the terrain is stable without appearance of tectonic structures (faults, overthrusts, synclines etc.). At several parts the alignment crosses regional and local roads, as well as smaller water flows.

From geological aspect the terrain is composed of young unbound sediments to metamorphosed rock masses such as:

At the subsections km 0+000-14+400 and km 31+930-39+600 the terrain is composed of Quaternary (Q) and Pliocene sediments (Pl), represented by sands, gravels, clays, sandy clays and other sediments, which are low bound to unbound, low to medium bound with appearance of groundwater at certain parts up to 2-3m from the ground surface, as favourable foundation medium. As medium for excavation, they belong to III- IV category according to GN 200.

At km 14+400 – 19+950 the terrain is composed of Cretaceous sediments, low metamorphosed limestones and limestone breccia, conglomerates, schists, metamorphosed sandstones and claystones, as well as massive limestones, low to medium fractured, very strong, at certain parts surficially highly weathered. As medium for excavation, they mainly belong to V category, at certain parts V and VI according to GN 200.

At km 19+950-23+100 the terrain is composed of Triasic, Jurassic and Cretaceous sediments, represented by limestones, marbelized limestones, fossil limestones, diabase and cherts, flysch sediments at the contacts with the serpentinite dykes. From tectonic aspect, they are medium to highly fractured at certain parts to crushed as a result of many faults, overthrusts and dykes. Considering the accessibility in the phase of construction, at the higher parts of the terrain along the alignment quite difficult conditions are expected, with possibility for appearance of smaller rockfalls. As medium for excavation, they mainly belong to V and VI category according to GN 200.

At km 23+100-31+930 the terrain is composed of Paleozoic chlorite-sericite schists, highly schistose, low to medium fractured, at the surface partially weathered. At the steep slopes there are possible appearances of instabilities such as local landslides, rilling, washing etc. in the part of diluvial-proluvial deposits. As medium for excavation, they belong to IV and V category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling, rockfalls, talus etc. are possible in the construction phase.

FIGURE 120 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: FERIZAJ - SUHAREKE

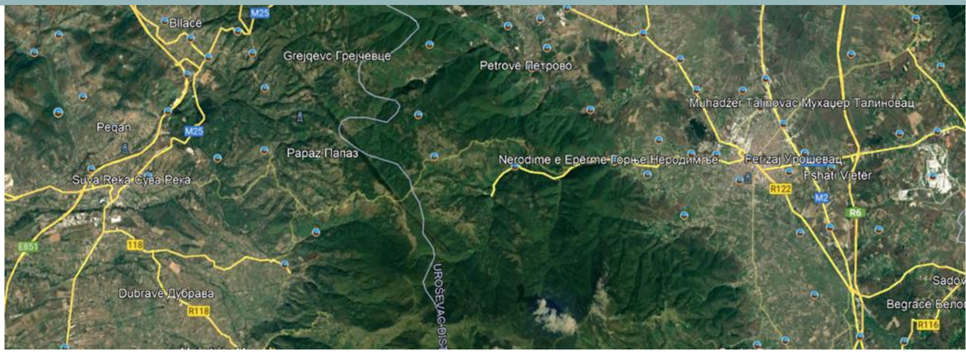


FIGURE 121 – SYNOPTIC GEOLOGICAL MAP, PAGES FERIZAJ AND RAHOVEC, SECTION: FERIZAJ - SUHAREKE

SECTION: Suhareke - Prizren km 39+600-54+950 (15,3 km)

From geomorphological aspect the terrain along the entire length of the alignment, is mainly planar (320-400 m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts, synclines etc.). At several locations the alignment crosses regional and local roads as well as smaller and larger waterflows, with many settlements and mainly agricultural land.

From geological aspect the terrain is composed of young unbound sediments to metamorphosed rock masses such as:

At the subsections km 39+600-41+700, km 44+500-45+130, km 47+150-47+550, km 48+250-49+150, km 51+200-52+100, km 52+900-53+100 and km 53+500-53+950 the terrain is composed of Quaternary alluvial-terrace sediments, represented by sands, gravels, clays, sandy clays and other sediments, which are unbound, with low density with appearance of groundwater, at depth at 3m from the ground surface, at certain parts also at 1-2m, as favourable foundation medium. As medium for excavation, they belong to III - IV category according to GN 200.

At the subsections km 41+700-44+500, km 45+130-47+150, km 47+550-48+250, km 49+150-51+200, km 52+100-52+900, km 53+100-53+500, km 53+950-54+950 the terrain is composed of coarse-clastic lacustrine sediments as well as Pliocene sediments represented by sand, gravel, clay, sandy clay, and transitions of the mentioned sedimentary materials. The present lithological units are unbound to low bound, low to medium bound, with appearance of groundwater, at depth up to 3-4m from the ground surface, as favourable foundation medium. As medium for excavation, they belong to III- IV category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds, whereas the appearances such as washing, rilling etc. can be rare occurrences in the phase of construction.

FIGURE 122 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: SUHAREKE - PRIZREN

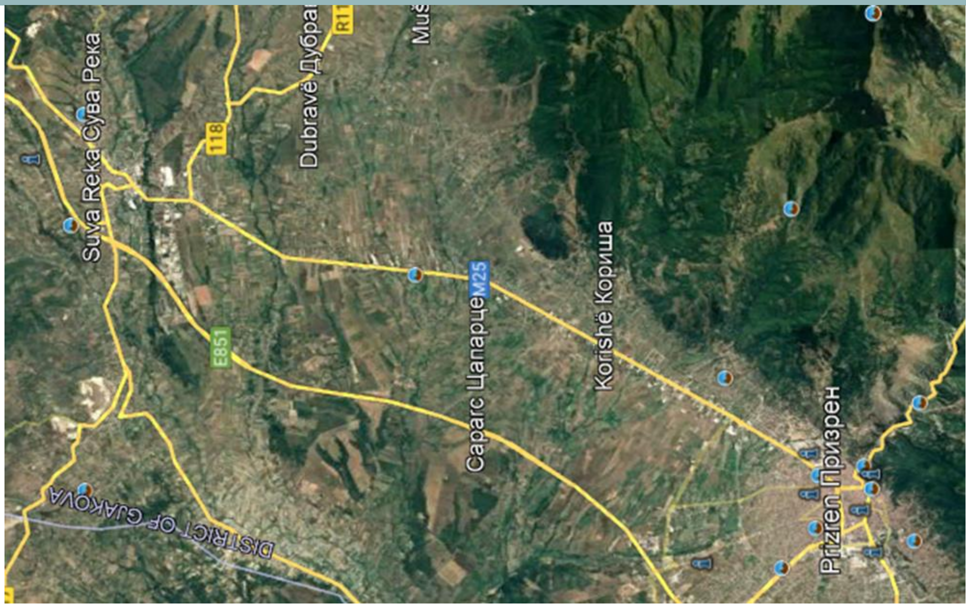


FIGURE 123 – SYNOPTIC GEOLOGICAL MAP, PAGES RAHOVEC AND PRIZREN, SECTION: SUHAREKE - PRIZREN

SECTION: Prizren - Krushë e Madhe km 54+950-68+170 (13,3 km)

From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (350-410 m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts etc.). Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, railway, as well as smaller and larger waterflows (river Topluga, Korishka river, Jaglenica etc.), with many settlements and mainly agricultural land.

From geological aspect the terrain is composed of young Quaternary (alluvial, proluvial and lacustrine sediments) which are unbound, and Pliocene sediments which are unbound to low bound being the following:

At subsection km 54+950-58+600 the terrain is composed of coarse-clastic lacustrine sediments as well as Pliocene sediments represented by sand, gravel, clay, sandy clay, and transitions of the mentioned sedimentary materials. The present lithological units are unbound to low bound, low to medium dense, with appearance of groundwater, at depth up to 3-4m from the ground surface, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

At subsection km 58+600-68+170 the terrain is composed of Quaternary proluvial and alluvial-terrace sediments, represented by sand, gravel, clay, sandy clay and other sediments, which are unbound, with low density with appearance of groundwater, at depth up to 3m from the ground surface, at some parts also up to 1-2m in the vicinity of the riverbeds, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds whereas the appearances such as washing, rilling etc. can be rare in the phase of construction.

FIGURE 124 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: PRIZREN – KRUSHE E MADHE

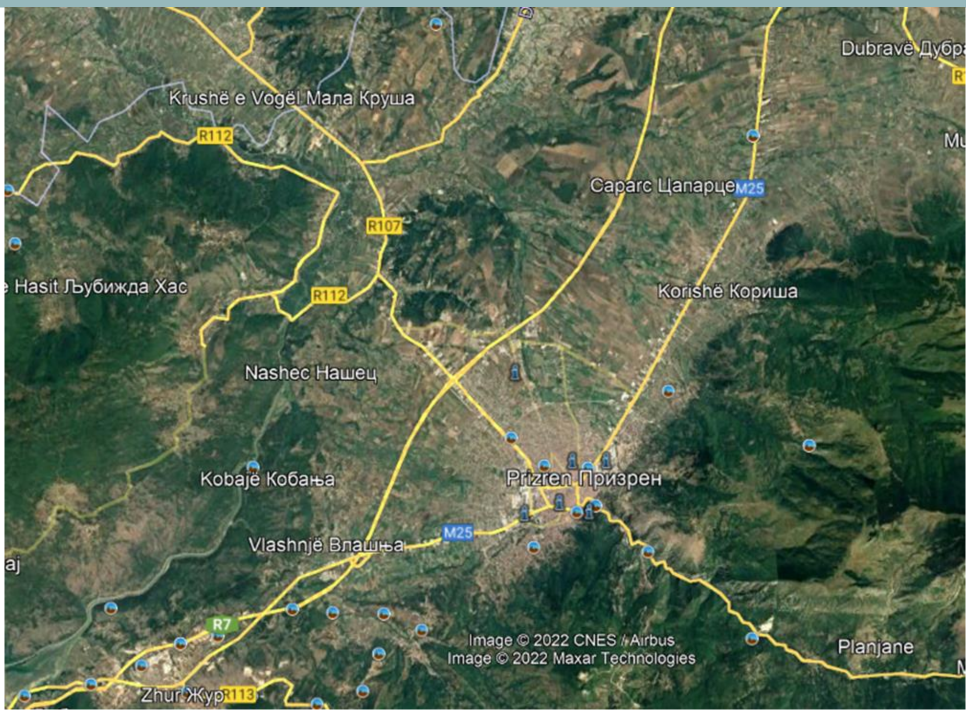
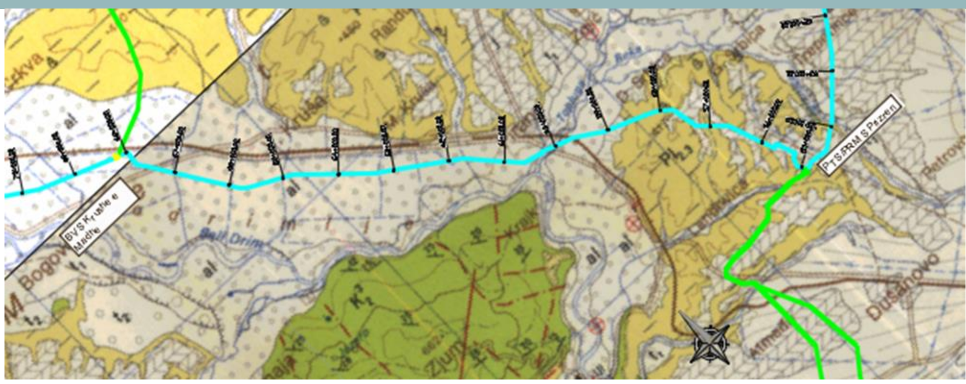


FIGURE 125 – SYNOPTIC GEOLOGICAL MAP, SECTION: PRIZREN – KRUSHE E MADHE



<u>SECTION: Krushë e Madhe - Gjakova km 68+170-83+700 (15,5 km)</u>

From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (340-400m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures (faults, overthrusts etc.). Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Drini I Bardh, Erenik and other smaller waterflows), with many settlements and mainly agricultural land.

From geological aspect the terrain is composed of young Quaternary (alluvial – terrace) and Pliocene sediments which are unbound to low bound, and Cretaceous sediments represented by limestones being the following:

At the subsections km 68+170-74+300, km 75+400-80+000 and km 80+300-82+000 the terrain is composed of Quaternary alluvial-terrace sediments, represented by sand, gravel, sandy clay etc. which are unbound, with low density and appearance of groundwater at depth up to 3m from the ground surface, at some parts also up to 1-2m in the vicinity of the riverbeds, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

At the subsections km 80+000-80+300 and km 82+000-83+700 the terrain is composed of Pliocene sediments represented by marly and sandy clay, sand and gravel and transitions of the mentioned sedimentary materials. The present lithological units are unbound to low bound, low to medium dense, with rare appearance of groundwater at depth greater than 5m from the ground surface, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

At subsection km 74+300-75+400 the terrain is composed of Cretaceous sediments, represented by limestones, reef fossil limestones which are bedded to thickly bedded. From tectonic aspect, there are rare occurrences of fault structures, being medium to highly fractured at some parts crushed. Considering the accessibility in the phase of construction, favourable conditions are expected. As medium for excavation, they mainly belong to V-VI category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds whereas the appearances such as washing, rilling etc. can be rare in the phase of construction.

FIGURE 126 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: KRUSHE E MADHE - GJAKOVA

FIGURE 127 – SYNOPTIC GEOLOGICAL MAP, SECTION: KRUSHE E MADHE - GJAKOVA

SECTION: Gjakova - Deçan km 83+700-107+550 (24 km)

From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (420-570 m a.s.l.), from tectonic aspect, the terrain is stable without appearance of tectonic structures. Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Trakanic, Proni mol etc.), with many settlements and mainly agricultural land.

From geological aspect the terrain is composed of young Quaternary (alluvial-terrace sediments) which are unbound and Pliocene and lacustrine sediments which are unbound to low bound being the following:

At the subsections km 83+700-86+600, km 87+200-87+500, km 94+650-94+850, km 96+200-97+130 and km 102+850-103+130 the terrain is composed of coarse-clastic lacustrine sediments as well as Pliocene sediments represented by marly and sandy clay, sand, gravel and clay with transitions of the mentioned sedimentary materials. The present lithological units are unbound to low bound, low to medium dense, with appearance of groundwater at depth up to 3-4m from the ground surface, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

At the subsections km 86+600-87+200, km 87+500-94+650, km 94+850-96+200, km 97+130-102+850, km 103+130-107+550 the terrain is composed of Quaternary alluvial-terrace sediments, represented by sand and gravel with rare presence of sandy clay, being unbound, with low density, with appearance of groundwater at depth up to 3 m from the ground surface, at some parts also up to 1-2m in the vicinity of the riverbeds, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds whereas the appearances such as washing, rilling etc. can be rare in the phase of construction.

FIGURE 128 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: GJAKOVA - DEÇAN

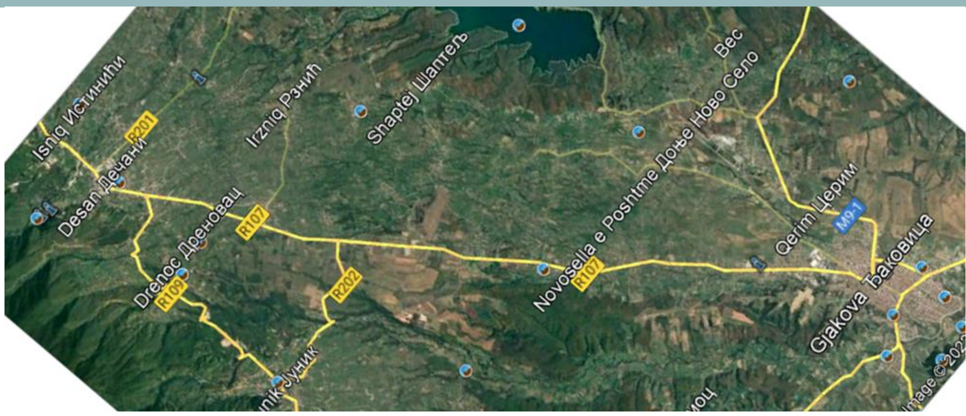
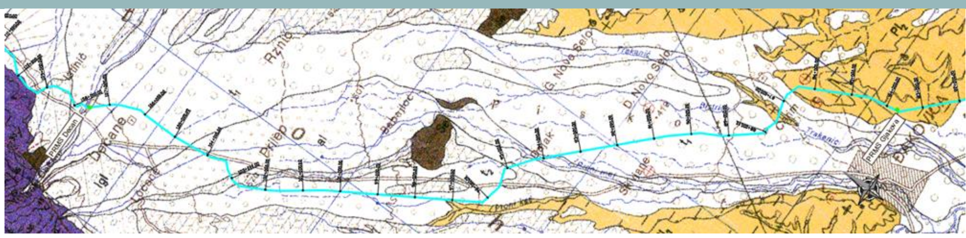


FIGURE 129 – SYNOPTIC GEOLOGICAL MAP, SECTION: GJAKOVA - DEÇAN



SECTION: Deçan - Peja km 107+550-119+700 (12 km)

From geomorphological aspect the terrain along the entire length of the alignment is mainly planar (500-540 m a.s.l.), from tectonic aspect the terrain is stable without appearance of tectonic structures. Contemporary processes such as rilling, washing, erosion etc. are well developed. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Decani etc.), with many settlements and mainly agricultural land.

From geological aspect the terrain is composed of young Quaternary (alluvial and proluvial sediments) which are unbound to low bound and Triasic sandstone, phyllite, chlorite schists, conglomerate, chert and limestones being the following:

At the subsections km 107+550-109+350 and km 110+105-119+700 the terrain is composed of Quaternary alluvial and proluvial sediments, represented by glacial materials (sand, gravel and clay with blocks from different rock masses, which are low to medium dense, low bound with appearance of groundwater at depth up to 3-5 m from the ground surface, at some parts also up to 2-3 m in the vicinity of the riverbeds, as favourable foundation medium. As medium for excavation, they belong to IV-V category according to GN 200.

At subsection km 109+350-110+105 the terrain is composed of Triasic sediments, represented by sandstone, phyllite, chlorite schists, conglomerate, chert and limestones. From tectonic aspect they are medium to highly fractured at some parts crushed as a result of many fault structures. Considering the accessibility in the phase of construction, at the higher parts of the terrain along the alignment, difficult conditions are expected with possible occurrences of smaller rockfalls. As medium for excavation, they belong mainly to V and VI category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion which is frequent appearance can be expected along the riverbeds, whereas the appearances such as washing and rilling are very well developed with frequent appearances of deep guillies.

FIGURE 130 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: DEÇAN - PEJA

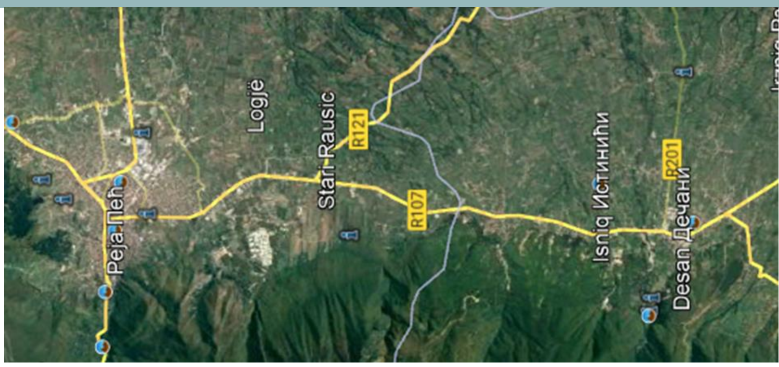
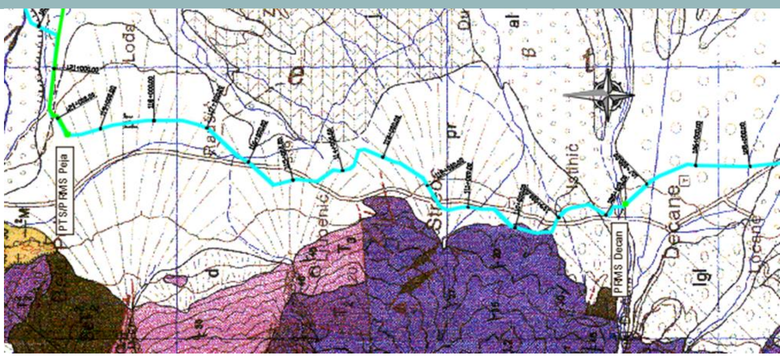


FIGURE 131 – SYNOPTIC GEOLOGICAL MAP, SECTION: DEÇAN - PEJA



SECTION: Pejë - Istog km 119+700-143+650 (24 km)

From geomorphological aspect the terrain along the entire length of the alignment is mainly planar with low hills (420-600 m a.s.l.), from tectonic aspect the terrain is stable without appearance of tectonic structures. Contemporary processes such as rilling, washing, erosion etc. are poorly developed with the exception of fluvial erosion. At several locations the alignment crosses regional and local roads, as well as smaller and larger waterflows (river Drini I Bardh river Istog etc.), with many settlements and mainly agricultural land.

From geological aspect the terrain is composed of young Quaternary (proluvial, alluvial and alluvial-terrace) sediments which are unbound and Pliocene and lacustrine sediments which are unbound to low bound being the following:

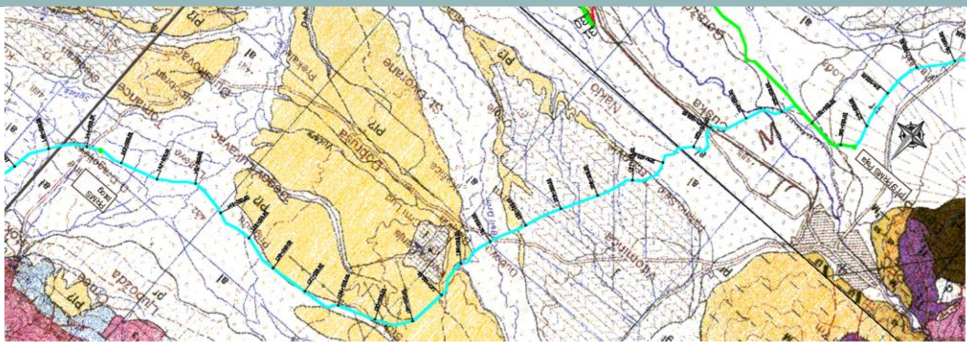
At the subsections km 119+700-126+430, km 130+400-132+250, km 135+300-137+000 and km 138+000-143+650 the terrain is composed of Quaternary proluvial, alluvial and alluvial-terrace sediments, represented by sand and gravel with rare appearances of sandy clay, which are unbound, with low density, with appearance of groundwater at depth up to 3-4 m from the ground surface, at some parts also up to 1-2m in the vicinity of the riverbeds, as favourable foundation medium. As medium for excavation, they belong to III-IV category according to GN 200.

At the subsections km 126+430-130+400, km 132+250-135+300 and km 137+000-138+000 the terrain is composed of coarse-clastic lacustrine sediments as well as Pliocene sediments represented by conglomerate, sandstone, breccia, sand, clay with transitions of the mentioned sedimentary materials. The present lithological units are unbound to low bound, low to medium dense, with appearance of groundwater at depth greater than 5 m from the ground surface, as favourable foundation medium. As medium for excavation, they belong to III-IV, V category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as fluvial erosion can be frequent appearance along the riverbeds, whereas the appearances such as washing, rilling, etc. can be rare.

FIGURE 132 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: PEJË - ISTOG

FIGURE 133 – SYNOPTIC GEOLOGICAL MAP, SECTION: PEJË - ISTOG



SECTION: Istog - Skenderaj km 143+650 – 171+597 (28 km)

From geomorphological aspect the terrain is from planar to hilly-mountaineous (470-780 m a.s.l.), from tectonic aspect the terrain is generally stable with appearance of tectonic structures (faults which cut the alignment). At several locations the alignment crosses regional and local roads as well as more larger waterflows (Rakoshka river, Radishevska river, Rudnichka river) and other smaller waterflows.

From geological aspect the terrain is composed of young unbound sediments to low metamorphosed rock masses being the following:

At the subsections km 150+450-150+750, km 151+450-152+080, km 152+230-152+430, km 167+850-169+000, km 169+800-171+000, km 171+220-171+597 the terrain is composed of Triasic and Cretaceous sediments represented by platy and thickly bedded limestones, volcanogenic sedimentary formation represented by claystones, schists, metasandstone, metadiabase and chert, flysch sediments represented by claystones, sandstone and marl, poorly fractures, partially decayed, covered by diluvial deposit with thickness of 2-3 m, at some parts in certain formations also quite strong. As medium for excavation they belong to V and VI category according to GN 200.

At the subsections km 149+600-150+000, km 150+750-151+450, km 152+430-152+900, km 154+080-154+330, km 154+800-155+850, km 156+170-163+850, km 164+320-167+850 the terrain is composed of Miocene sediments, represented by clay, marly clay, marl, sand and gravel, low bound, medium to very dense with appearance of groundwater at depth greater than 5m, favourable as foundation medium. As medium for excavation they belong to IV and V category according to GN 200.

At the subsections km 143+650-149+600, km 150+000-150+450, km 150+550-150+700, km 152+080-152+230, km 152+900-154+080, km 163+850-164+320 and km 166+100-166+800 the terrain is composed of alluvial, alluvial-proluvial and lacustrine unbound sediments and low bound sediments, with appearance of groundwater at depth greater than 3m. There is gravel and sand, with low density, favourable as foundation medium. As medium for excavation they belong to III and IV category according to GN 200.

Most of the alignment runs through agricultural land. It can be concluded that it is favourable for construction of this type of structures. Engineering-geological processes and appearances such as washing, rilling etc. are frequent. The landslide process is well expressed at the part of v. Chitak to Rudnik. At this part of the alignment in the phase of detailed investigations more attention should be paid.

FIGURE 134 – SYNOPTIC GEOGRAPHICAL MAP FOR SECTION: ISTOG - SKENDERAJ

FIGURE 135 – SYNOPTIC GEOLOGICAL MAP, SECTION: ISTOG - SKENDERAJ